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E. L. Carroll  
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A. J. Underwood  
Western Adv. Mgr.  
3-210 General Motors Bldg.  
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Tel.: Trinity 2-0606

■ SAE DETROIT BRANCH

808 New Center Building  
Tel.: Madison 7495  
R. C. Sackett, Staff Rep.

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Petroleum Bldg.  
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Tel.: Prospect 6559  
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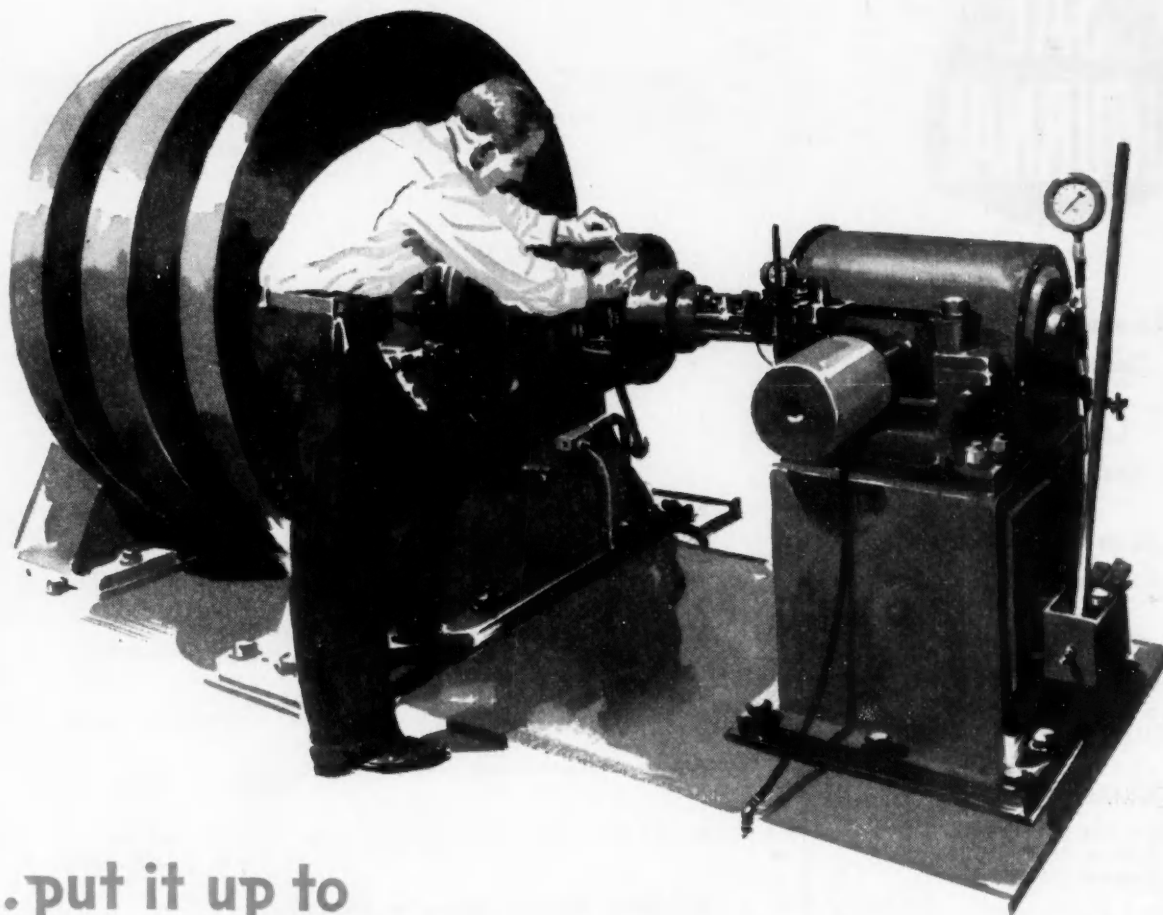
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JANUARY  
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...put it up to

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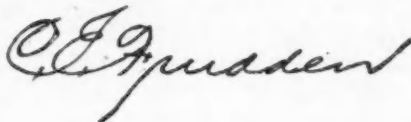
# President's Report for 1947

## To All Members.....

For one who as President has been privileged to sit in the councils of the Society and also to see close-up and at first hand the workings of its many Sections, Groups, committees, and other activities, the year 1947 has been a great adventure and a grand experience. From this special vantage point, affording a fine overall view of what's going on in SAE and its widespread activities, it appears that the aims and accomplishments should stamp this as having been a good year for the Society.

The statistics reported herein as to growth, interests and work done during the year tell their story well, as to the loyal devotion to the Society's welfare by not just a selected few but by a large percentage of its total members, and also by a very capable headquarters staff, for their excellent interpretation of the wishes of the members and for their ability to combine ideas with suitable action, SAE can well be generous in its thanks for a job well done.

And to all who have taken part in the year's activities, may I add my personal thanks for all of the work done which has made the year a most pleasant one—and, we trust, at the same time a profitable one to SAE.



Your President for 1947 has traveled widely. He has seen at close range the workings of most Sections and Groups; has attended national meetings in widely scattered areas. These close-up contacts have emphasized the tremendous potentiality of our organization, not only for aiding members to advance their individual professional standings, but also for serving those industries which depend upon SAE to handle such technical problems as require cooperative attention.

Outstanding, at all levels of SAE activities, is the spirit of fraternalism which exists and makes possible rapid development of technical interests within an industry that lives and thrives on the fiercest of competition.

Statistically, 1947 has been a good year for SAE.

Membership continued to increase; student enrollment doubled. Meetings maintained their high level of interest, and the publication expansion program was completed.

Technical Board committees achieved importantly in work on materials used in both ground and air equipment, in advisory service to government agencies and in bringing SAE standards in line with postwar needs.

Section meetings were more numerous, attendance greater than ever before—and policies applying to Sections and Groups were clarified in several important areas.

Financially, this fiscal year ended with a \$23,000 loss on operations, but with expenses curtailed to permit a definite profit to be budgeted for 1948-49.

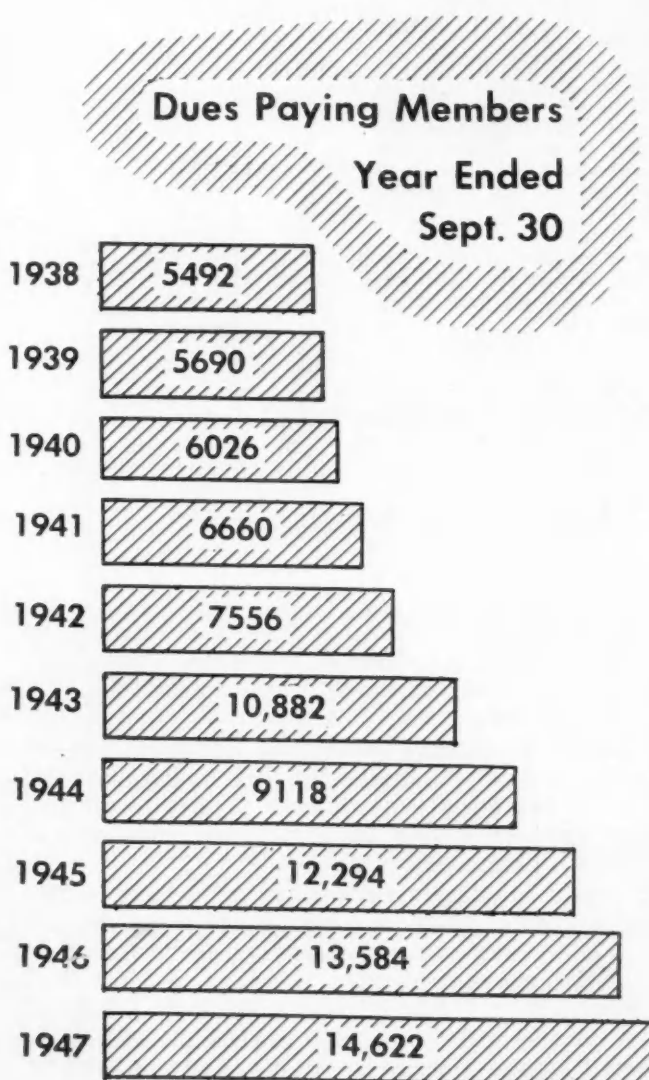
## Membership Increases — 13th Consecutive Year

Membership is still on the increase, as it has been for 13 consecutive years. The 14,622 net paid total reported at the end of the fiscal year marked an increase of 1038 over the previous year.

Higher than normal membership losses during the past year still left at about 1.8 to 1 the ratio of new members to members lost through death, resignation, and cancellation.

Forecasts by Section, Group, and Activity membership chairmen indicate faith in continuance of the present trend. During the fiscal year, 2011 applications for membership or reinstatement were received. Flow of applications is expected to continue . . . withdrawals to taper off.

Recent Council action waived initiation fees for



Enrolled Students moving directly into Junior membership status in the Society. Following this action, about 55% of eligible Enrolled Students became Junior members without a break in their SAE affiliation. In 1945 and 1946, when initiation fees were required, only 30% and 28% respectively carried on.

## Students Double

Student Enrollment in the Society reached new heights during 1947 as more than 2600 engineering students attending 75 engineering colleges made use of the special SAE student affiliation. Total number of students on the Society's rolls was more than double that of the highest previous year.

At the same time 22 chartered Student Branches sponsored a variety of technical meetings, smokers, field trips, and on occasions were hosts to local Sections for campus technical programs.

Upon recommendation of the Student Committee the Council authorized establishment of new Branches at Lawrence Institute of Technology, Northrop Aeronautical Institute, Rensselaer Polytechnic Institute, San Diego State College, and State College of Washington. Provision was made for benefits identical to those of Student Enrollment to be extended to student veterans who have passed the 30-year age limit stated in the SAE Constitution. This has enabled numerous older undergraduates to become familiar with the Society and to take part in local Branch activities.

Governing Boards of many Sections gave direct support to student programs. Working with Branch officers and faculty advisers, they aided in securing speakers, arranged plant visits, and included special student meetings in their schedules of functions.

## Technical Work Widens on Land - Air Projects

The SAE Technical Board and the technical committees operating under it have made 1947 a year of outstanding service to the automotive industries. Particularly significant are the accomplishments on materials used in ground and air equipment, the advisory services rendered to government agencies, and intensive activity to bring SAE standards and recommended practices in line with postwar needs.

The revision of the SAE steel standards ranks high among 1947 accomplishments because of its far-reaching technical and economic significance.

The new list, which reflects current automotive practice, lists 55 new steels, these additions being offset by the elimination of 47 compositions, mostly in the National Emergency category. The modifications were effected with the close cooperation of the American Iron & Steel Institute, and, as a result, differences between the SAE and AISI lists have been minimized.

In the aeronautical field, development of a complete series of Aeronautical Material Specifications for corrosion- and heat-resistant alloys has been pursued aggressively to cover new materials required in jet engines and their installations. Twenty-five specifications in this series already have been issued. In addition, the AMS for copper alloys have been brought up to date; and new and revised AMS for plastics used in airplane construction have been issued. The AMS are proving to be of greater and greater value to the aeronautical industry as the years go by and their usefulness is receiving increasing recognition from the armed forces.

On other materials fronts, SAE technical committees have completely revised non-ferrous metal specifications, modifications have been made in the standards for rubber compounds, work has been in progress on fuels and lubricants, and a start is being made on standards for paper and fiber materials.

In the field of government cooperation, one of the major developments of the year has been recognition accorded SAE aeronautical standards for accessories and equipment by the Civil Aeronautics Administration. These minimum performance standards for equipment for civil aircraft, which are developed by engineers from industry and government working cooperatively, are now referred to in CAA Technical Standards Orders which authorize the use of equipment meeting the SAE standards. Eleven standards in this category were completed during the year and others are under development.

The SAE also has been privileged to cooperate with the Interstate Commerce Commission on proposed revisions in its safety regulations for motor carriers. Among the subjects on which SAE committees have worked are window construction specifications, rear bumpers for trucks and side-mounted gasoline fuel tanks. Reports also have been submitted to the Armed Forces on boron-treated steels, controlled-soil vehicle testing, torsionographs and calibrators and the Army's winter test program.

An entirely new field of standardization work was pioneered during 1947 with organization of the Construction and Industrial Equipment Technical Committee. In this field of rapidly expanding automotive importance, a comprehensive SAE program of standardization now is well under way and is receiving enthusiastic support from engineers in this area of automotive manufacture.

Other projects which illustrate the scope and

extent of SAE technical committee activities include the following:

The SAE screw threads standard has been completely revised to provide a comprehensive manual on screw thread practice. In addition, the Society is participating actively in the work that is going on to unify American, British and Canadian screw threads practice.

Three Aeronautical Information Reports on helicopter problems and one on dual rotation propeller shaft ends have been issued. In addition to the aircraft equipment standards previously referred to, 10 new aeronautical standards and recommended practices have been completed. During the year, 35 new and 53 revised AMS have been published.

Work has been inaugurated on an automotive drafting manual as a counterpart to the outstandingly successful Aeronautical Drafting Room Manual. Ultimately it is hoped that it may be possible to secure agreement on a single manual for both ground and air. Looking still further ahead, the work SAE is now doing on the drafting problem may be looked upon as a necessary preliminary to getting together with other industries in the development of an American standard drafting practice.

A new standard for automotive brake lining and rivets has been developed which, it is expected, will operate to simplify greatly the present complicated service problem.

In the field of motor vehicle lighting, a specification for back-up lights has been completed, and work is well along on standards for headlights for motorcycles and scooters, both of which come under state motor vehicle regulations.

Future designs of farm tractor wide base rear tires are the subject of a new recommended practice, and simplification of the tractor tire, rim, and wheel picture is receiving continuing study. The SAE tractor test code also is being reviewed.

In cooperation with the AISI a joint publication on hardenability has been issued. This pamphlet includes tentative hardenability bands for 60 steels which now may be purchased on this basis.

Problems of installing two-way radio on motor vehicles have been studied intensively and a report issued providing fleet operators with basic information on this important topic. As a by-product of this activity, radio manufacturers have gained a better understanding of the problem of fitting their equipment to motor vehicles.

Rounding out the series of spring design manuals which the Society has published is a new manual on torsion bars. In addition, a translation of a German book on spring problems containing much of value to American engineers is being published.

American Standards developed under the procedure of the American Standards Association, which have been approved by the Society, include machine pins, involute splines, plain washers, spindle noses, taps, and screw threads.

## ***Publications Expand to Full Technical Coverage***

SAE Journal and SAE Quarterly Transactions together brought almost twice as much technical material to members in 1947 as in any previous year, completing the first full year of operation of the expanded program which made the two publications complementary to one another, carrying different, not duplicating, material.

### ***SAE Journal***

SAE Journal brought promptly to members material from *every* paper presented before the Society—in form ranging from very brief digests to extensive feature treatment. As the year closed, no backlog of papers remained untreated in SAE Journal.

In addition, SAE Journal was able for the first time to report adequately and regularly the progress of SAE technical committee work, in addition to giving quicker and fuller attention to news of Sections, personal items about members, administrative committee operations, and other SAE news.

During the year, the revised SAE Journal won a first prize for design format in the Annual Business Paper Editorial Awards sponsored by Industrial Marketing, in which leading business and technical publications participate.

### ***SAE Quarterly Transactions***

In 1947, SAE Quarterly Transactions carried 693 pages of full-length technical papers, as compared with 620 and 748 in the Transactions Section of the SAE Journal in 1945 and 1946 respectively, the last two complete calendar years in which that Section was carried in SAE Journal and later sold in bound form as Annual SAE Transactions.

Quarterly Transactions currently has a considerable backlog of approved-by-Readers-Committee, but unpublished papers. Time between date of presentation and publication is the same as for the Transactions Section of SAE Journal in 1945. In 1947 Quarterly Transactions, it averaged 6.74 months; in 1945 SAE Journal, 6.76 months.

The relatively permanent character of the papers selected for SAE Quarterly Transactions, combined with the extensive treatment of the more timely papers in SAE Journal, however, reduces materially the importance of this time factor from a service-to-members standpoint.

In 1947, about 60% of SAE members subscribed to SAE Quarterly Transactions.

### ***Special Publications***

Special Publications Department continued to extend its services to members in 1947. Nearly 14,000 copies of SAE technical committee reports and more than 60,000 copies of SAE meetings papers were distributed through this operation in the fiscal year ending Oct. 1. With nonmembers charged twice as much as members for all Special Publications items, the Department operated at a profit of 7.5% on sales.

All illustrations—photographs as well as line drawings—now are included in the multilithographed copies of meetings papers sold through the Special Publications Department and at National Meetings. Previously only line drawings were made available in these papers.

## ***Innovations in Meetings Keyed to Changing Needs***

Eleven National Meetings were held in automotive centers throughout the country during 1947. The year's schedule was marked by changes and innovations introduced to adapt the meetings to the shifting peacetime needs of our membership and their industries. The total attendance of 9000 and the 211 papers presented are slightly lower than record 10,000 attendance and 226 papers established during 1946.

However, 1947 does boast three records. The 1947 Annual Meeting, the Tulsa Fuels and Lubricants Meeting and the Kansas City Air Transport Meeting were the largest of their kind ever held by the SAE. Annual Meeting attendance was almost 5000; its 66 papers, 30 technical sessions, 89 committee meetings, 50 display booths, and 3500 dinner attendance all topped previous marks. A 500 attendance peak was recorded at the 1947 Tulsa and Kansas City meetings.

In an SAE National Transportation Meeting co-sponsored by the Transportation and Maintenance and Truck and Bus Activities, these Activities merged their complementary interests for the first time in many years to their mutual benefit.

The first SAE National Meeting devoted entirely to personal aircraft was held in Wichita, Kans., in May, 1947.

The first new meeting form in SAE National Meetings in many years was introduced at the National Production Meeting, held in Cleveland on Oct. 20-21. One day of this meeting was given over to an all-day Production Clinic composed of nine

## National Meetings Sessions Papers

Year	Number of		
	Meetings	Sessions	Papers
1941	7	64	118
1942	7	52*	102*
1943	9	73	146
1944	10	97	185
1945	**	**	**
1946	11	112	226
1947	11	112	211

\*Drop caused by sudden cancellation of Summer Meeting.

\*\*Figures not significant — seven National Meetings cancelled because of Meetings ban by the Government.

simultaneous panel discussions on vital production problems.

Other innovations in SAE National Meetings during the year were made to promote membership, increase efficiency, and contribute needed increase to SAE income.

## More and Better Meetings Mark 1947 Section Growth

Sections and Groups worked hard and successfully at getting full meetings schedules outlined early in the Section year. Results: more meetings, better meetings, and marked increases in member

attendance. Thirty-two Sections and Groups were hosts to the SAE President.

"Guideposts" for Section and Group financial operations were an important development this year, as were regulations governing Section and Group affiliation with other local organizations. Both were set up by Council committees on which the Sections Committee was represented, and were approved by Council. Cleveland, Wichita, Cincinnati, Canadian, Buffalo, and Philadelphia Sections were authorized under the latter rules to affiliate with local engineering organizations in their areas.

Council approval advanced Spokane and Virginia Groups to Section status, the former as "Spokane-Intermountain." Peoria became Central Illinois Section, and expanded to include eight additional counties. Hawaii Section extended its activities to the Island of Maui, named a vice-chairman to represent members on that Island.

Sections and Groups are becoming increasingly active in the Society's placement program. At the Placement Committee's request, they contribute to the program by counseling members seeking new connections and urging companies to use the facilities of the SAE Placement Service.

## Specialized Effort Marks Public Relations Program

Public relations operations in 1947 were marked by a definite increase in the number of special articles about SAE activities printed in leading technical magazines and in newspapers such as the New York Times, Wall Street Journal, Detroit Free Press, Louisville Courier Journal, Indianapolis News and others of similar caliber.

Routine publicity releases on meetings and other SAE events were continued on a normal scale and found widespread use in both technical magazines and newspapers.

These were the result of special effort to interest feature writers in SAE and encourage them to come to the Society for information and data to use in articles of their own writing. This effort was typical of work done toward developing better understanding of SAE among executives of automotive companies. Direct contact with many executives was increased also by continued publication of the SAE Technigram in which SAE technical committee news was briefed, and by a considerable special correspondence following presentation of papers by engineers of particular companies.

Plans for 1948 involve a continuance of these same activities to the fullest extent possible under current budget allocations.

## Income and Expense Hit an All-time High

In the fiscal year ended Sept. 30, 1947, Society income and expense reached an all-time high. However, inflationary tendencies which caused a \$23,000 deficit were evident early in the year and were counteracted in some measure by efforts which brought us home some \$66,000 under our original budget. The deficit, plus economic uncertainty, dictated a budget for the new fiscal year \$114,000 lower than its predecessor. This was accomplished by direct action which launches us on our new fiscal year with an 11% reduction in staff, 17% reduction in occupied space, and a general economy program covering innumerable items. That such substantial economies have been effected at a time when services to members enjoy a broader scope than ever before testifies to the efficient engineering of the curtailment program. The entire effort has pursued the philosophy of greatest possible savings with least possible modification of member service.

Income has also been predicted on the conservative side, with Journal advertising revenues set at \$250,000 as compared to the recent rate of \$300,000. Despite this, the budget indicates a profit with which the Finance Committee is eager to build up reserves which, in these transition years, have been drawn upon to provide essential services. They now stand at \$420,000, or some \$20,000 below their peak.

Generally rising costs have had their inevitable effect on the Society's operations and we are now engaging in a study of the financial aspects of membership dues.

Industry's appraisal of Technical Board operations becomes increasingly gratifying as evidenced by larger financial support than ever before on the part of industry. Despite this, the direct cost of these operations was not completely covered and the Council has established the policy, to begin with the 1948-49 fiscal year, that direct expenses for Technical Committee activities will be budgeted no higher than the previous year's support from industry.

The Society's financial condition remains excellent, as is shown on the accompanying chart. The results of the sound policies and planning of the SAE Finance Committee are revealed by our audit. The detailed figures are included in this report.

### BALANCE SHEET

As At Sept. 30, 1947

In Agreement with Haskins & Sells Audit

Assets	
Cash—Unrestricted .....	\$80,901.87
Restricted .....	14,707.14
Notes & Accounts Receivable—Less Reserve .....	20,617.00
Securities—Cost Value .....	356,193.00*
Accrued Interest on Securities .....	2,341.42
Inventories .....	1,031.75
Deposits .....	575.00
Furniture & Fixtures .....	1,000.00
Deferred Charges .....	35,243.89
<b>Total Assets .....</b>	<b>\$512,610.87</b>
Liabilities & Reserves	
Accounts payable .....	\$13,486.40
Members Dues Received in Advance .....	36,646.81
Deferred Credits to Income .....	21,797.92
Reserve for Unexpended Contributions .....	10,649.19
Reserve for Retirement Plan Contributions ..	10,409.07
General Reserve .....	419,621.48
<b>Total Liabilities &amp; Reserves .....</b>	<b>\$512,610.87</b>
* Book Value (Quoted Market or Redemption Value—9/30/47—\$350,667.88).	

Income	Membership		Meetings	Publications		Misc.	Industry
	\$884,736.86						

Expense	Membership		Meetings	Publications		Misc.	Industry
	\$907,816.66						

**INCOME AND EXPENSE**  
12 Months Ending Sept. 30, 1947  
In Agreement with Haskins & Sells Audit

Income			Expenses		
<b>Membership</b>			<b>Sections &amp; Membership</b>		
Dues Earned .....	\$176,336.25		Sections & Student Branches..	\$16,126.41	
Subscriptions Earned .....	75,755.75		Section Appropriations & Dues	46,549.78	
Initiation Fees .....	40,332.50		Membership .....	27,408.02	
Miscellaneous Membership			Placement .....	6,730.73	
Income .....	1,377.11	\$293,801.61	West Coast Office .....	21,278.70	
			Miscellaneous Membership		
			Expense .....	5,970.65	\$124,064.29
<b>Publications</b>			<b>Pro-Rated Administrative</b>		
Journal Sales .....	15,626.87		Expense (17.3%) .....		32,825.56
Journal Advertising .....	298,182.00				156,889.85
Handbook Sales—1946 .....	7,025.14		<b>Publications</b>		
Handbook Sales—1947 .....	7,320.85		Journal Editorial .....	102,856.37	
Handbook Advertising .....	15,100.00		Journal Advertising .....	108,554.27	
Transactions Sales—1945 & Prior	336.00		Handbook Editorial—1946 ....	881.60	
Transactions Sales 1946 .....	4,716.00		Handbook Editorial—1947 ....	39,902.99	
Transactions Sales—1947 .....	13,676.50		Handbook Advertising .....	3,666.62	
Aeronautical Publications .....	11,930.68		Transactions—1945 & Prior ...	45.39	
Special Publications .....	24,084.15		Transactions—1946 .....	11,469.84	
Miscellaneous Publications ....	4,912.28	402,910.47	Transactions—1947 .....	33,082.90	
			Aeronautical Publications ....	9,388.84	
<b>National Meetings</b>			Special Publications .....	22,240.77	
Guest Registration & Papers			Miscellaneous Publications ....	16,064.85	348,154.44
Sold at Meetings .....	4,649.05		<b>Pro-Rated Administrative</b>		
Dinners & Luncheons .....	25,843.02		Expense (48.5%) .....		92,025.40
Displays .....	11,708.00				440,179.84
Summer Meeting .....	6,878.00	49,078.07	<b>National Meetings</b>		
			Department Expense .....	31,342.60	
<b>Industrial Income for Technical</b>			Cost of Papers and		
Board Services—Earned ....		129,538.17	Registrations .....	985.23	
			Meetings .....	35,307.48	
<b>Interest &amp; Discount</b>			Dinners & Luncheons .....	26,969.83	
Interest Earned .....	9,207.42		Displays .....	5,813.70	
Discount Earned .....	201.12	9,408.54	Awards .....	232.50	100,651.34
			<b>Pro-Rated Administrative</b>		
Total Income .....		\$884,736.86	Expense (14%) .....		26,564.03
					127,215.37
			<b>Technical Board Services</b>		
			Technical Committee Operations	105,385.22	
			CRC Appropriation .....	35,000.00	
			Miscellaneous Expense .....	4,218.27	144,603.49
			<b>Pro-Rated Administrative</b>		
			Expense (20.2%) .....		38,328.11
					182,931.60
			<b>Total Direct Expense</b>		
			.....	717,473.56	
			<b>Total Administrative Expense</b>		
			(Pro-Rated above) .....	189,743.10	
			<b>Total Expenses</b>		
			.....		907,216.66
			Contingent Fund .....		600.00
			Loss on Sale of Securities .....		
			<b>Total Expenses &amp; Loss</b>		
			.....		907,816.66
			<b>Operating Deficit</b>		
			.....		—23,079.80
			<b>Total Income</b>		
			.....		\$884,736.86

# PENNY-WISE Plane Design

## DOLLAR Saving Production

BASED ON A PAPER\* BY

**GEORGE W. PAPER**

Production Design Department Engineer,  
Lockheed Aircraft Corp.

**T**HE time is now for the design engineer to realize that he is the key to low-cost aircraft production. He alone through his drawings and specifications establishes the airplane's minimum cost. Only by adhering to economic production-design principles can he minimize that minimum.

His job is so important because he sets the pattern for routines most other departments in the

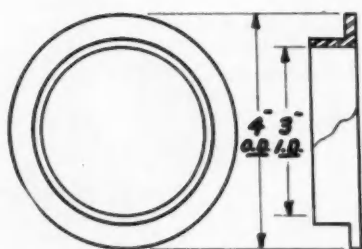
company will follow for each plane or part of that design.

Degree of factory efficiency, tooling ingenuity, and purchasing resourcefulness will determine how closely the factory approaches the minimum cost. But none of these techniques, no matter how efficient, can reduce the airplane's cost below the minimum established by the designer. This industry team gains no yardage toward the goal of low cost if the quarterback fumbles the ball, no matter how strong the production line.

Even the designer himself fails to appreciate the

\* Paper "The Designer and Manufacturing Costs," was presented at SAE National Aeronautic Meeting (Fall), Los Angeles, Oct. 4, 1947.

### 1. RAW MATERIALS



#### STEEL BUSHING

Made from Bar (12 #) \$1.44

Made from Tube (1.5 #) .26

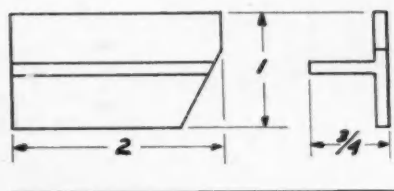


Any given airplane calls for a minimum amount of material to meet basic functional and structural requirements. Cost of this minimum amount of material is beyond the designer's control.

But when drawings call for material exceeding the minimum - closer tolerances, special sizes, or to meet higher-than-necessary physicals - the cost exceeds the minimum.

This excess is within the designer's control.

In the example shown, choice of a bar over a tube for making the part would increase its cost 5.5 times. And an engineer selecting a bar at 10¢ over extrusions at 7¢ releases a design 1.4 times more expensive than necessary. These two cases are typical of hundreds of similar parts and assemblies where the designer wasted money by failing to exercise complete control over material selection.



#### ALUMINUM BRACKET

Made from Bar \$1.10  
Made from Standard Extrusion .07

# Yields Costs

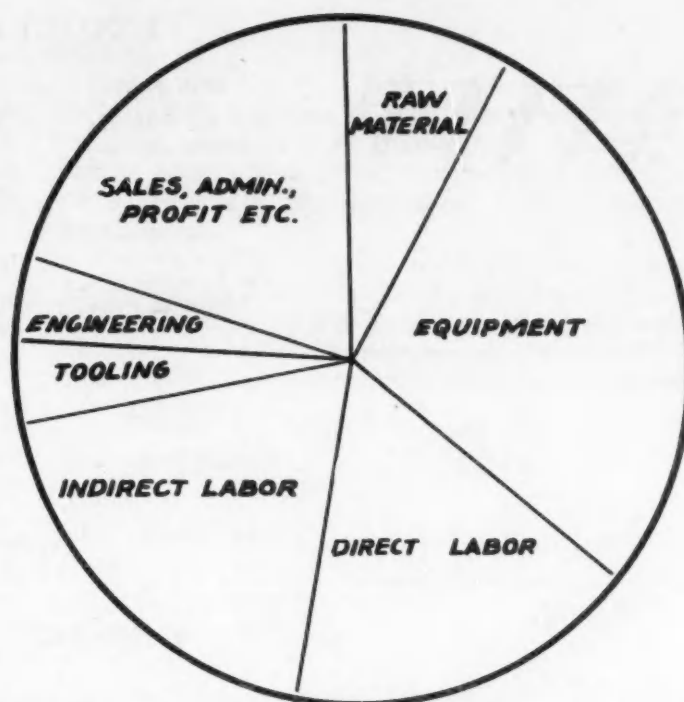


Fig. 1 - How a transport airplane's manufacturing costs are distributed

influence of his work on manufacturing costs. Yet if we examine each segment of a plane's cost, shown in Fig. 1, we will see how his every activity and criterion affects each of these elements.

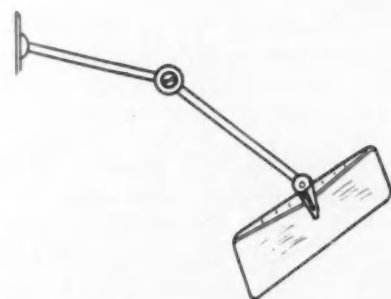
His design can expand or contract each piece of the cost "pie." Or he can change the ratio of one piece to another. Both sales price and margin of profit depend on his ability to shrink the total area.

Total effect of design on manufacturing costs may be as high as 30 to 35%. Closer attention to design influence on major cost elements - raw materials, equipment, direct and indirect labor, tool-

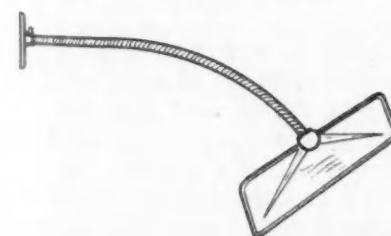
ing and engineering - will reduce this percentage. Ways of achieving these savings are shown in the examples that follow.

While these examples may seem insignificantly small, they were purposely chosen to stress the importance of today's problem - economical detail design. Difference between a minimum-cost detail design and a higher-costing one is generally small enough to get by supervision. But cumulatively, these little differences add up to imposing figures.

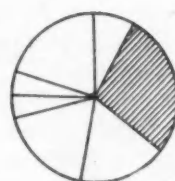
## 2. EQUIPMENT



**SUN SHADE**  
Made in Accordance  
with Designer's Spec-  
ifications ... \$12.80



Purchased as Standard  
Item (Used in Low-  
Cost Automobile) ... \$1.20



Percentage of control over equipment is somewhat smaller than for material since much of the cost is tied up in engines, propellers, customer-required gadgets, minimum CAR safety requirements, and company policy

commitments.

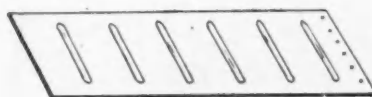
But one important point to remember in selecting equipment is that the most expensive is not necessarily best. Nor should equipment performing more functions or more efficient than necessary be chosen unless its cost and service record are in keeping with the quality and functional and price standard set for the airplane.

This is one piece of the cost "pie" where costly frosting can be eliminated from the design recipe without impairing the part's function or performance. The example shows how the designer might miss the boat.

### 3. DIRECT LABOR



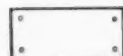
**SKIN PANEL**  
Skin and Stiffeners  
Riveted Together \$.80



One Piece Skin with  
Reinforcing Beads .09



**GUSSET**  
Rounded Corners \$.02



Square Corners \$.01



Direct labor represents man-power dollars spent in actual manufacture of the design by the sheetmetal worker, welder, riveter, and other skilled workers. The designer may reduce direct labor at the expense of material or tooling. Or he may increase direct labor by designs which do not permit use of economical tooling or factory methods.

It's his responsibility to strike a fine balance between labor, tooling, and material costs based on total quantity and schedule to produce the most economical part.

These two examples of how labor cost is affected by design are based on production quantities of about 50 to 100 airplanes total.

### 4. INDIRECT LABOR



Indirect labor consists of two parts. The first is direct labor overhead such as supervision, maintenance, and personnel service, and that part of manufacturing overhead such as procurement, planning, scheduling,

dispatching, and order control.

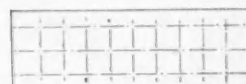
The second part stems from existence of parts and details. Effect of design on this portion of indirect labor is roughly proportionate to the number of parts going into the airplane.

The example illustrated is a typical control surface assembly. Indirect cost for each design is based on those functions necessary to process the part through the paperwork system. It includes items such as planning, tool ordering, fabrication and assembly ordering, accounting, and inspection.

#### DESIGN I

Total Parts	20
Different Parts	15
Identical Parts	6

Contract Indirect  
(Paperwork) Cost \$484.00



#### DESIGN II

Total Parts	20
Different Parts	20
Identical Parts	0

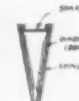
Contract Indirect  
(Paperwork) Cost \$624.00



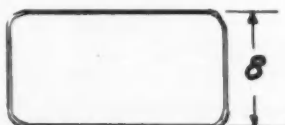
#### DESIGN III

Total Parts	9
Different Parts	4
Identical Parts	6

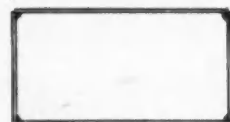
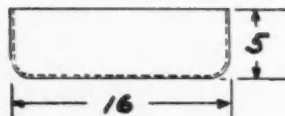
Contract Indirect  
(Paperwork) Cost \$218.00



### 5. TOOLING



**COVER BOX**  
Drawn Box  
(Rounded Corners) \$450.00



Welded Box  
(Square Corners) \$57.00



As much as 30% of the tooling cost is within the designer's hands. Care in selecting structural breakdown, type of joints, and design of details—all requirements for good tooling—ties in directly with part and assembly design.

Uneconomical breakdown and joint or structural design may cost thousands of tooling dollars. Wasteful design of one detail part may not run into four figures; but uneconomical design of thousands of details and small assemblies will cost thousands of needless tooling dollars. Although small, the mistake illustrated is probably repeated many times on every airplane.

## 6. ENGINEERING



Changes in design after release due to design errors increase paperwork, release processing, and direct engineering manhours. It always costs more to correct a poor drawing than to release an accurate one in the first place.

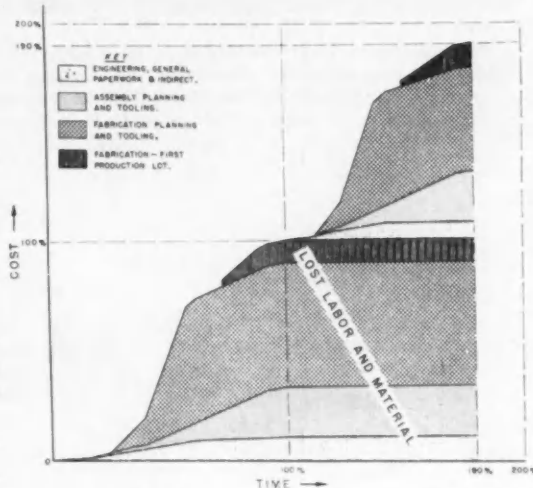
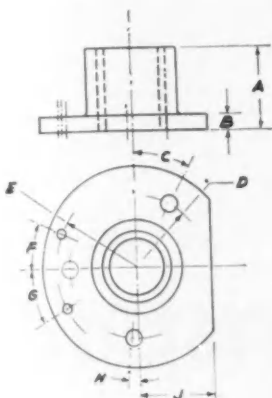
The example at left shows what happens to engineering costs when incomplete or erroneous information is released. Pyramiding of costs achieved through release of faulty drawings, depicted in the

chart below, increases factory as well as engineering costs. Spending 20% more time in design to assure accuracy and correctness often will save 10 to 50 times the equivalent cost in factory expense.

Every time the designer makes a mark on paper, he is spending company money. Accurate and well-planned marks involve spending of a reasonable amount of money. Inaccurate and poorly-planned marks often cost more than can be realized by sale of the product.

### FLANGE FITTING

RELEASE NUMBER	ENG. HOURS
1. ORIGINAL Release as Shown	48
2. "A" Dimension Changed (Interference)	16
3. "D" & "E" Dimensions in Error—Closer Tolerances Added	20
4. "F" & "C" Dimensions in Error—Changed to Offsets	18
5. "B" Dimension Unsatisfactory—Closer Tolerances Added	16
6. "C" Dimension Changed to Offsets	19
7. "I" Dimension Reduced Because of Interference	16
8. All Unnecessary Dimensions—Deleted and "Mate with . . ." Note Added Because of Tooling Difficulty	18
9. Part Obsolete, Completely Redesigned and Re-Released Because of Shop Squawks	48
No Errors—No Changes	
<b>Total Hours</b>	<b>219</b>
<b>Unnecessary Hours Spent</b>	<b>171</b>



## FOR THE DESIGNER'S NOTEBOOK . . . 15 Cost-Saving Design Principals

Every designer would do well to clip and paste in his notebook these 15 production-design principles. He should learn them as well as he does the formulas he uses every day and should apply them with equal astuteness. These principles are:

1. Design a part to fulfill its basic functions as a unit complete within itself. Consider adjacent structure only for attachment and clearance.

2. Design small components with circular cross-section and straight center line. This facilitates engineering design and shop production and permits standardization and multiple use of parts.

3. Permit access for assembly operations such as riveting and spot welding.

4. Joints between assemblies should consist of a few concentrated point attachments rather than a series of attachments.

5. Cowlings, fairings, fillets, and similar parts should not be fastened across joints of main assemblies, locations of which may vary considerably.

6. When attaching to contoured areas, provide flat pads rather than attempting to mate the entire area.

7. Avoid cross tolerances—especially on sheet metal.

8. Design for self-alignment and self-adjustment of items such as control bellcrank levers.

9. When two bearings must be in line and it is not possible to support them in one integral part, the bearings should be mounted on the surfaces normal or parallel to their centerline.

10. In nonstructural or semistructural applications, minimize the use of aluminum alloy sheet which requires heat-treatment after forming.

11. Design stampings and formed parts to provide for die access.

12. Incorporate as many elements as possible integral with structural members to diminish the number of parts required. Design parts to perform multiple functions where practical.

13. Maintain a consistency in type and structures, restricting shapes and gages to a minimum.

14. Design identical parts and assemblies rather than left- and right-hand mirror reflections.

15. Isolate the complicated features of a design to as few of the components as possible.



Administrator of Civil Aeronautics T. P. Wright, left, with Brig.-Gen. Milton W. Arnold (Ret.), vice-president, operations and engineering, Air Transport Association of America, and SAE Past-President E. P. Warner, head of the International Civil Aviation Organization

# Mass Air Transport

**A**IR transport engineers are absorbed in preparing all phases of the industry to complete the transition from small-scale operation to mass transportation.

Seeking technical improvements to facilitate growth, they have not forgotten that growth depends on economics. The twin themes of building up revenue and cutting down expenses ran through all sessions of the SAE National Air Transport Meeting, held Dec. 1 to 3 at the Hotel Continental, Kansas City, Mo. Engineers were found exploring every means of providing better service to attract more customers. At the same time, they are revising designs and procedures to raise efficiency.

Speakers discussed how to promote growth both directly and by improving service and efficiency. Remarkable international cooperation in standardization of regulations was reported. Airlines were reminded that if they would exercise the same degree of cooperation in standardization of their equipment, they could reap tremendous savings.

Aircraft builders were told that air cargo volume will justify a new plane designed specifically for air-cargo use. They were given a novel analytical method for selecting the optimum airplane-power-plant combination to do a given job. Design problems in keeping noise out of the cabin and making windshields impact-resistant were aired.

Ground equipment came in for a large share of

attention. New ideas in airport planning include less-extensive runway systems and provision for easier passenger circulation in terminals. Airlines are concerned with cutting expenses of ground operations — which totaled 57.7% of total operating costs in the first six months of 1947 — through more efficient use of personnel and equipment. Cooperative airport arrangements and a new plan for air-traffic control were described.

SAE members and guests were shown how the International Civil Aviation Organization works to standardize national aircraft regulations. The ICAO offers internationally-prepared advice to the sovereign states of the world, particularly to the 44 which have ratified the International Convention on Civil Aviation. Each contracting state undertakes to keep its own regulations uniform with those established from time to time under the convention.

There are no international civil air regulations enforceable by any world agency, just as there is no world government with power of action. But the ICAO has made impressive progress in securing uniformity in the three years since the Convention was drawn.

Airlines have two approaches to the meetings of the ICAO — through their national delegations and through the International Air Transport Association, which is regularly invited to send representa-



The Honorable W. E. Kemp, mayor of Kansas City, left, who, as toastmaster of the dinner Wednesday night, introduced SAE Secretary and General Manager John A. C. Warner, principal speaker in the unavoidable absence of James M. Landis, CAB chairman, with SAE President C. E. Frudden and Chairman W. E. Breece of the Kansas City Section, which served as host to the SAE National Air Transport Engineering Meeting in that city Dec. 1 through 3

## Featured at Kansas City

tives to ICAO meetings.

Standardization in the field of equipment can be made to pay dividends of convenience and economy. According to one speaker, only 4% of current airline expenses can be charged to competitive cost items such as advertising and personal passenger service. The other 96% is the cost of noncompetitive activities—activities where distinctive variations generally do not serve to attract passengers. These activities offer broad fields where standardization would save money.

If scheduled airlines could agree on uniform ground equipment, consolidated volume orders would save them thousands of dollars. The same holds for aircraft; one discussor startled his listeners with the statement that the airlines could have saved \$100,000 per plane on a certain new 4-engine transport if all had agreed to accept identical versions.

Speakers and discussors alike praised the SAE for its standardization work. They urged aircraft operators and manufacturers to expand their use of SAE standardization machinery.

### New All-Cargo Plane Needed

Importance of air cargo to the air transport industry was driven home by statistics: This country's all-cargo air fleet has grown in five years

from one airplane of 6000-lb capacity to 102 aircraft with a combined capacity of 1,181,700 lb. The stability of demand for air cargo service makes it good business. The recent series of airline accidents has cut sharply into passenger revenues, a speaker declared, but air shipment of cargoes has mounted without any sign of shipper concern.

The armed services have proved that all-weather flying is practicable for all-cargo operations. All-weather flying will not only improve service to customers, but the increased utilization of equipment and personnel will shrink costs.

Prime need of the air-cargo industry, it was said, is a plane designed especially for cargo carrying, to replace today's converted passenger aircraft. The new design was pictured as allowing for a loading density somewhere between the 5.1 lb per cu ft of cabin space of the converted passenger aircraft and the 18.8 lb per cu ft of the rail express car.

The load would be protected from shifting due to take-off accelerations, vertical gust loads, turbulent air in flight, and landing impact. Tiedown arrangements should be sufficient to hold the maximum payload under the stress for which the plane is designed. The best means of securing the load seems to be rope cargo nets fastened to rails along the sidewalls and tiedown fittings recessed in the floor.



Meetings Chairman R. C. Loomis, who was responsible for planning the Air Transport meeting, left, and R. G. Horridge, chairman of the Kansas City Section Committee on arrangements and William H. Hooper, chairman of the Section's Reception Committee

The cargo compartment should be located at truck level. There should be enough doors so that loading and unloading at through stops can be accomplished during the plane's routine servicing.

It was recommended that cargo planes be equipped with V-tabs, aerodynamic balancing tabs, or some similar device for compensating for variations in the location of the center of gravity.

#### New Tool Cuts Design Time

Designers of commercial aircraft were given a new tool for determining the optimum airplane-powerplant combination to do a given job. The originator of the method defined the optimum combination as the one which will meet the given specifications for speed, altitude, range, and payload with lowest take-off gross weight. Then he showed how the ratio of payload (plus fuselage needed to accommodate the payload) to take-off weight can be found from a consideration of aerodynamic laws and engine characteristics. The airplane-powerplant combination having the highest ratio will be the optimum arrangement.

The analysis enables the design analyst to find out how any powerplant of known characteristics fits into the overall airplane-powerplant picture. Also, it gives operators and manufacturers a means of determining the limiting cruising speed beyond which it is uneconomical to go for a given range and altitude.

The method eliminates the need for designing and calculating the performance of whole families of airplanes of different sizes, wing loadings, power loadings, and aspect ratios. A close approximation to the optimum can be reached in a matter of hours instead of months. The method does make use of several curves based on past experience—curves of wing-plus-tail weight and of fuselage weight, for example.

One discussor observed that for cargo aircraft, the fuselage-weight curve ought to be modified to agree with the higher cargo loading densities advocated by the air-cargo representative. Standardization enthusiasts pointed out that while the airplane-powerplant analysis might indicate a large

airplane as optimum for the job, an airline might find it more economical to buy several smaller planes of a design produced in large volume than one large plane of an uncommon design.

#### Explains Cabin Acoustics

Reverting to the theme of pleasing the customer, another speaker gave suggestions on designing quiet cabins. He said that the particular sound spectrum required for a given type of operation depends largely on what the passenger expects. In modern transport aircraft, the passenger may reasonably expect that cabin noise will permit easy conversation with nearby passengers, be free of irritating qualities, and be not uncomfortably loud.

The noise problem should be attacked by reducing noise at its source and then minimizing the remaining noise through proper acoustical treatment of the interior. Experience with cabin acoustics shows that glass-wool blankets effectively attenuate high-frequency noises. A thin layer of impenetrable material is more effective against low frequencies. A sheet of mica will add mass, and its layer construction will help damp fuselage skin panel vibrations.

Jet-engine proponents were able to chalk up one credit on the noise score. The jet engine was reported to be quieter than the reciprocating engine in one test where the reciprocating engine was run at 65% power and the jet engine at full power in two planes of the same basic airframe. Measurements were made at the pilot's position, ahead of the engines.

A possible reason was disclosed for the disagreement over which type is quieter. Comparison of the noise of engines operating on test stands showed that noise from the jet engine is nearly as high as from the conventional engine at low frequencies and very much higher at the higher frequencies. Some of the high-frequency noise is eliminated with operation in the airplane because, of course, the engine is enclosed. Also, jet-engine noise is concentrated at the rear of the engine. Passengers located forward of the engine do not hear all the noise.

Collisions of birds with commercial aircraft are not so small a safety hazard as they might seem. A CAA report set forth data indicating that bird collisions occurred at the rate of more than one a day at the 1946 level of airline operations. More than 25% of all strikes result in severe local damage to some portion of the aircraft structure. Airplane windshields are struck more frequently than any other part.

The CAA is engaged in developing windshields which will resist impact with birds in flight. They have found that for high impact strength, the best windshield construction uses a thick layer of vinyl plastic between the layers of glass and an extended flexible plastic edge with a metal insert. The assembly is bolted to the airplane frame structure.

### New Ideas on Airports

As air transport volume increases, ground facilities must keep pace. New airports are going to be needed, and they must be built to provide economical and convenient service, keyed to the needs of the region they serve, speakers agreed.

Two distinct trends which have a conflicting effect on airport planning exist today. Such developments as Jato, cross-wind landing gear, and reversible-pitch propellers indicate that future planes will be able to use considerably shorter runways. Opposed to these developments are the ever-increasing size of transport planes and the adaptation of jet propulsion to transports — developments calling for longer and heavier runways.

Consensus of discussion was that it would be good for the air transport industry if a moratorium were declared on the increasing of plane sizes and they were held to a maximum of 250,000 lb until service facilities could catch up with planes.

Air-cargo planes need fairly long, heavy runways. Yet many small communities which would benefit from air-cargo service cannot afford to build a network of heavy-duty runways.

The airport planners' answer to the problem was to construct one long, heavy runway, besides the usual runways needed to obtain wind coverage for light planes. Larger aircraft employing tricycle landing gear and heavier wing loading can operate in cross-winds up to 30 mph. Therefore, the long runway should be laid out in the prevailing direction of winds over 30 mph.

A city-planning engineer brought out that the single-long-runway idea might diminish complaints of airport neighbors about noise. Aircraft could afford to maintain a higher altitude over residential sections surrounding an airport if they had a longer run over the field itself.

Airline engineers did not approve the unidirectional system, but they agreed that the runway pattern could be simplified to some extent.

Economy in the design of airport terminal buildings demands that the number of gates be kept to a minimum. Gates must be arranged so that the

passenger knows where to go and doesn't have to walk too far to get there. The terminal must be helped to pay its own way through valuable concessions — concessions convenient for both passengers and visitors to patronize.

The best approach to terminal planning, as one industrial engineer outlined it, is:

1. Determine what types of traffic will exist and the amount of each on a daily basis.

2. Convert these figures to the number of schedules required.

3. Convert the number of schedules to the number of plane parking positions needed, using reasonable time figures.

4. Lay out the parking positions, beginning at the right-hand end with outbound positions, then through positions, international inbound, and, finally, domestic inbound. This order permits ground transportation vehicles first to discharge and then to pick up passengers as the vehicle progresses along the airport drive.

The first three steps insure that the terminal will be adequate for the traffic but not excessively large. The fourth step simplifies passenger circula-

Concluded on page 57

Based on first-hand reports of discussions and papers presented at the SAE National Air Transport Meeting, Dec. 1-3, Kansas City, Mo., at seven technical sessions and one dinner. Chairmen of technical sessions were C. P. Graddick, L. R. Inwood, R. C. Loomis, Luke Harris, H. H. Howell, T. P. Wright, and Leslie Myers. W. E. Breece was dinner chairman, Mayor W. E. Kemp of Kansas City was toastmaster, and President C. E. Frudden and Secretary and General Manager J. A. C. Warner were dinner speakers.

Papers were: "Determination of Optimum Airplane-Powerplant Combination," by J. M. Brewster, III, Fairchild Engine and Airplane Corp.; "Cargo Aircraft Requirements," by J. J. Casey and R. D. Speas, American Airlines, Inc.; "Design of Airport Terminal Buildings," by Walther Prokosch, George S. Armstrong Co.; "Economical Airport Planning," by H. O. Wright, Jr., Public Airport Services, Inc.; "Standardization and Simplification for the Air Transport Industry," by William Littlewood, American Airlines, Inc.; "Air Transport Ground Operating Costs," by Robert Ferguson, Pan American Airways; "Problems of International Standardization of Civil Air Regulations," by E. P. Warner, International Civil Aviation Organization; "Importance of Noise Reduction in Airport Location and Layout," by J. M. Picton, Kansas City Planning Commission; "Problems of Noise Reduction from the Airplane Design Standpoint," by H. L. Ericson, Douglas Aircraft Co., Inc.; "Proposed Air Traffic Control and Controlled Handling Systems for High Speed Aircraft," by Brig. Gen. M. W. Arnold, Air Transport Association of America; "Collision of Birds with Aircraft in Scheduled Commercial Operations in the Continental United States," by C. L. Pigman, CAA; and "Investigation of Windshield Materials and Methods of Windshield Mounting to Resist Impact with Birds in Flight," by Pell Kangus, CAA.

# How Farm Implement Linkage

BASED ON A PAPER\* BY

**Knud B. Sorensen and Stanley Madill**

ENGINEERING DEPARTMENT, JOHN DEERE TRACTOR CO.

(This paper will be published in full in SAE Quarterly Transactions)

**C**ONTROL linkage and other farm implement elements can be redesigned to use power control capacity efficiently and to adapt the implement to more than one tractor.

The linkage most nearly producing the ideal rectangular work diagram for the hydraulic cylinder's lift cycle makes the most of available power control. There are several ways of making the linkage give nearly uniform cylinder pressure for heaviest lift conditions throughout the lift cycle.

It can be done in the case of initial linkage designs giving high pressure peaks at beginning or

end of cycle. This condition is most common at the cycle's end—in converting from wheel lift to power control. The wheel usually has lightest load and least traction at this point.

The work diagram in Fig. 1 shows such condition produced by the faulty linkage design in Fig. 1(a).

Fig. 1(b) suggests one possible improvement. Merely widening the angle between the two bellcrank arms corrects the shortcoming. The original work diagram shows that mechanical advantage wants to be decreased at the beginning and increased at the end. A bigger bellcrank arm angle changes the cylinder's relative working stroke position. It increases arm length as the cylinder extends and gives a uniform rate of mechanical advantage increase at this point.

Uniform rate of mechanical advantage increase

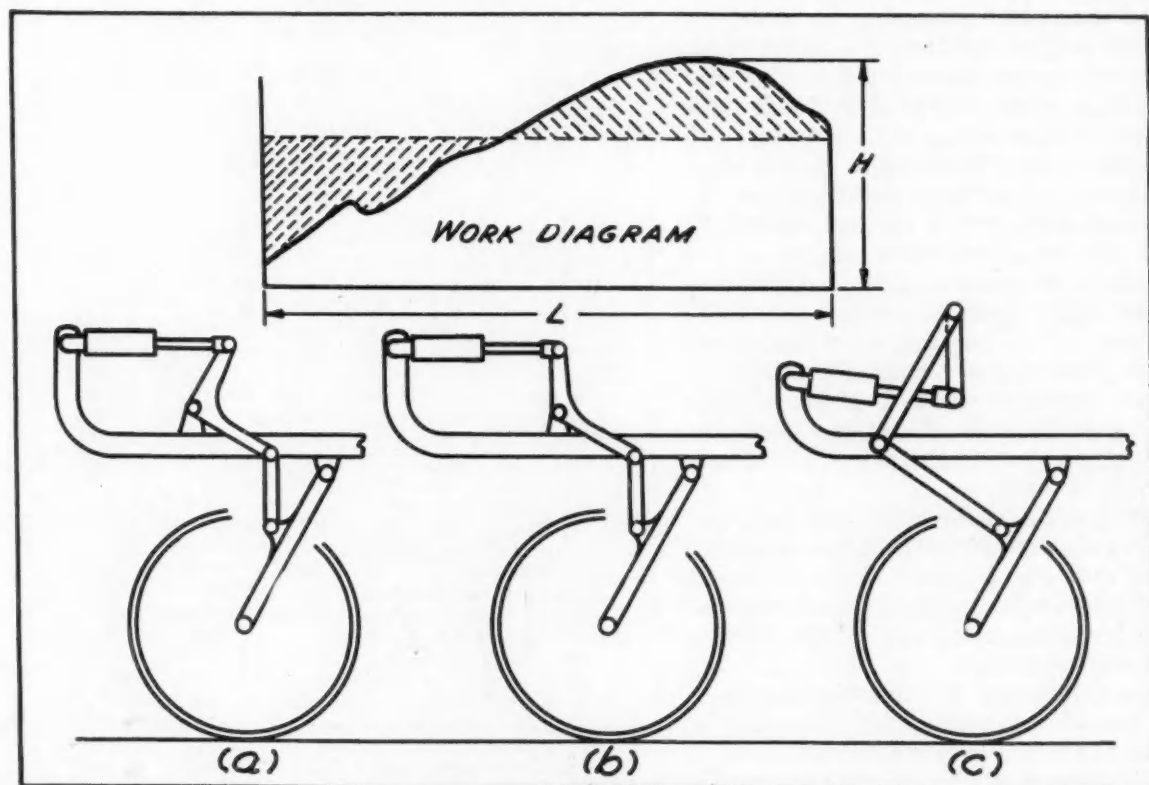


Fig. 1—The power control linkage in (a) produces a peak pressure at the end of cylinder stroke, as the work diagram shows. Redesigned linkages in (b) and (c) level off the work diagram

# Best Uses CONTROL POWER

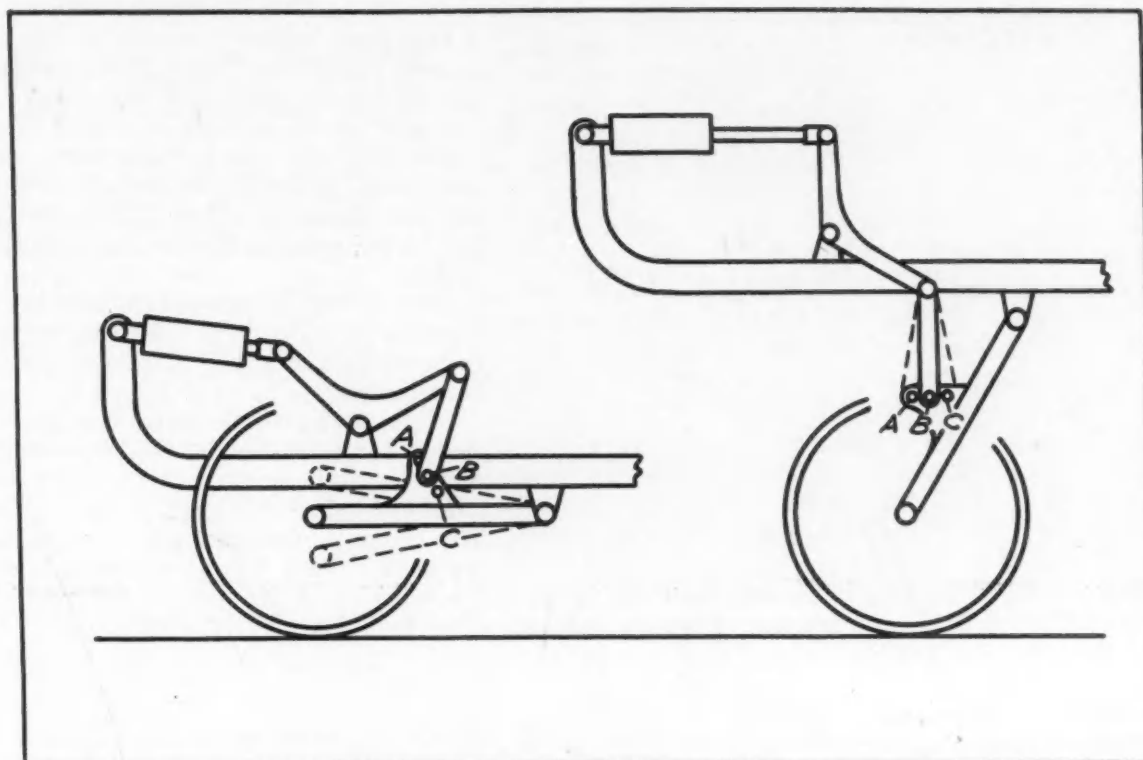


Fig. 2—This adjustable control linkage permits a small tractor to handle a larger implement. It keeps maximum tool working depth within tractor drawbar horsepower

at this point more than offsets its decrease due to gradual effective lengthening of the bellcrank-to-axle link.

Second linkage modification, Fig. 1(c), brings about constant cylinder pressure by reversing the bellcrank; it now rotates in the opposite direction. This design reduces change in effective length of the bellcrank-to-axle link. Desired mechanical advantage here stems from positioning the bellcrank arms with respect to cylinder stroke and wheel axle.

The second design is more flexible than the first in getting desired lift rate. But both will level off the work diagram. Disadvantage of the second lies in the reversed bellcrank mounting; but it does give smaller bellcrank bearing loads with the cylinder horizontal.

Advantage of both designs can be combined by reversing the axle position so that the wheel mounting trails the bellcrank—as in Fig. 1(a)—

with the axle parallel to it. Thus both bellcrank and axle rotate clockwise.

First step in achieving these corrected designs is to plot rate of lift against cylinder stroke on a curve sheet. The designer can get this data graphically from the linkage layout or by measurements on the implement. After selecting the lift diagrams with the worst peak pressure conditions, he should next divide them into equal stroke increments and measure the area in each. Next step is to divide each measured portion of area by the average total diagram height; multiply it by the reduction ratio in the indicator drum drive linkage. This will give the theoretical portion of the stroke to be used for that amount of work.

Plotting these points on the same curve sheet will compare the theoretically-accurate lift rate curve with the actual. Corrections necessary to get uniform pressures throughout the lift cycle will show up on these curves. Linkage revisions

can be checked by plotting the lift rate curve against the theoretical one.

This same approach holds in redesign of linkages producing lift diagrams high at the beginning and low at the end. The uniform rate-of-lift linkage is a case in point. Soil reactions while lifting the tool out of the ground are heaviest at the beginning; they decrease as the soil breaks loose and falls away. This condition calls for a linkage with highest mechanical advantage at the beginning.

These examples cover linkage correction of only excessive peak pressure conditions; total work requirement was within power control system capacity. If total work exceeds the system's capacity, applying the following corrective measures will reduce required work:

1. Reducing both moving linkage parts and pivot point friction. In some cases lengthening bellcrank arms and positioning them for balancing the loads will materially reduce friction losses. This lowers bearing load at the fulcrum.
2. Reducing total lift height. This makes for maximum use of the available cylinder work stroke and a proportionate reduction of total work.
3. Reducing total implement weight and use of auxiliary lift springs.
4. Reducing unnecessary tool motion in the soil during lift. The tool should be raised up without forward motion. Otherwise the cylinder must overcome both soil resistance and a portion of the implement draft load.

Proper linkage design can also mate an implement to more than one tractor. For example, a

moldboard plow may be set up for a maximum working depth of 12 in. Only one of three tractors may have sufficient drawbar capacity to handle it. Suppose the second tractor will handle a 10-in. depth and the smallest an 8-in. depth.

Without an adjustable linkage, only two-thirds of the smallest tractor's available cylinder stroke is used to raise the implement from its full 8-in. working depth. A linkage must be designed using the full stroke for each of the three maximum depths.

#### Making Linkage Adjustable

One such design is shown in Fig. 2. The three holes - A, B, and C - for the bellcrank-to-axle link are horizontal with the implement raised. Thus the link can be connected in any one of the three holes and still provide the same raised ground clearance. In the lowered position, the three holes are one above the other. Changing the link from one to the other will vary the maximum working depth.

This design allows small tractors with lowest capacity power control to handle larger implements to maximum working depth within its drawbar horsepower.

Other desirable features can be built into the design for light-weight implements and for those requiring light power-control loads. For example, a linkage using only part of the stroke gives quick lift. Some implements may require fine depth adjustment. Such linkage must reduce lift rate in the working depth range, but provide rapid lift after tool clears the ground.

## SAE 1948 ANNUAL MEETING

JANUARY 12-16

Hotel Book-Cadillac  
Detroit, Mich.

### DINNER SPEAKER:



### WILLIAM HAZLETT UPSON

Noted writer and humorist (author of the "Earthworm Tractor" stories made famous in the Saturday Evening Post)

Wednesday  
Jan. 14  
6:30 p. m.

Detroit Masonic Temple  
500 Temple St.  
Detroit, Mich.

# President for 1948

## R. J. S. PIGOTT

A trenchant, versatile, accomplished engineer takes over the SAE presidency in 1948. He is Reginald James Seymour Pigott, who since 1929 has been chief engineer of Gulf Research & Development Co., at Pittsburgh, Pa.

President-elect Pigott has been an SAE member since 1918 and was a councilor in 1945 and 1946. He is also director of Automotive Engine Projects for CRC and chairman of the CRC Engine Section. He has appeared on the speaking programs of many SAE national meetings and frequently has contributed technical articles to SAE Journal.

His professional record shows 11 years in the design, construction, and operation of central steam power stations; a year as Professor of Engineering at Columbia University teaching power station and steam turbine design and power machinery; five years in metal manufactures; seven years in designing and constructing power and industrial plants, office buildings, laboratories, and garages; and 18 years in petroleum engineering research.

The record includes more than 30 patents on devices in the power station and oil-production fields, including side-wall ventilation for stokers, rubber expansion joints, vacuum trippers for turbines, household oil burners, valves and gages, intake screens, internal gear and gear-tooth shapes, deep-well pumping units, automatic devices and instruments, machines for testing bearings and lubricants, rotary compressors and pumps, nozzles for spraying viscous oils, self-aligning sleeve bearings, hydraulic variable-speed transmissions, and metal working machines.

He has written nearly 40 technical papers on power station design, fluid flow, instruments, vapor lock, lubrication, superchargers, and aviation fuel and lubrication systems published in technical and trade magazines, in the proceedings of numerous technical societies, and in scientific handbooks. He has rendered extensive service as consulting engineer, as expert in patent litigation, and as designer of power and industrial plant projects worth approximately \$100,000,000.

Pigott's present position places him in charge of engineering research for Gulf Oil Corp., and its subsidiaries and divisions, with responsibility for Gulf engineering research and design, laboratory buildings, operation of shops and drafting rooms, progress in the techniques, tools, and equipment utilized in producing crude oil, design and fabrication of test equipment, solution of mechanical problems for the corporation's divisions and standard engine testing to qualify fuels and lubricants. Research in the development of special equipment includes such projects as the "marsh buggy" and piston ring pressure tester.



During the war a good deal of research work was done for the automotive industry, particularly aviation, covering the investigation and solution of the problem of oil foaming in flight, heat distribution in high output aviation engines, the solution of difficult bearing problems for gas turbines and engines, and the manufacture of a good deal of special test equipment.

He was born Feb. 4, 1886, at Wellington, Shropshire, England, and received his early education in the public schools of New York. He was graduated by DeWitt Clinton High School in 1902 and by Columbia University, with a degree in mechanical engineering, in 1906. He received the University Medal in 1946.

He has served as chief draftsman, assistant engineer, and consulting engineer for Interborough Rapid Transit Co.; as superintendent of construction for New England Engineering Co.; as consulting engineer or manager for Remington Arms-Union Metallic Cartridge Co.; Crosby Steam Gage & Valve Co.; Gradon Manufacturing Co.; Stevens & Wood, Inc., and other firms.

By-product accomplishments additionally include smoke abatement for Bridgeport, Conn.; standardization of oils and cutting compounds for Remington Arms; introduction of new designs in safety valves and steam gages for Crosby; tube mill improvement for Bridgeport Brass; design of light-weight, one-man street car with independently-sprung wheels; and codification of stoker design.

He was first president of the American Society for Measurement and Control, now the Pittsburgh Chapter, Instrument Society of America. He is a member of Theta Xi, and of Tau Beta Pi, Sigma Tau and Sigma Xi honorary fraternities.



# SAE Councilors



Completing the 1947-48 term as councilors are C. H. Miller (top), White Motor Co.; Elmer McCormick, John Deere Tractor Co.; and Marcus L. Brown, Jr., Seiberling Rubber Co. of Canada, Ltd. C. E. Frudden, Allis-Chalmers Mfg. Co., and L. Ray Buckendale, Timken-Detroit Axle Co., continue on the Council as past-presidents. B. B. Bachman, Autocar Co., serves again as treasurer.

## E. E. Husted

Councilor E. E. Husted (M '27) is president of Titeflex Metal Hose Co. in Newark, N. J. He came to Titeflex in 1924, and was sales engineer, then sales manager, vice-president (in charge of all engineering), general manager, and became president in 1942.

Husted went from Colorado State College to France, as a captain in the AEF, and stayed with the Army of Occupation. He holds the rank of lieutenant colonel in the Reserve Corps.

After the war he went to the Yukon gold fields to do engineering deposit-survey work.

For years he played a leading role in the administration of Metropolitan Section, serving on several committees before his election as chairman for the 1943-44 Section year.

## Paul E. Hovgard

Councilor Paul E. Hovgard (M '42) became general manager of Piasecki Helicopter Corp. last year. He had been

associate director of Cornell Aeronautical Laboratories.

He has been in the aircraft industry continuously since he studied mechanical engineering at Kansas State College of Agriculture & Applied Science. He has worked for Travel Air Mfg. Co., Keystone Aircraft Corp., Pennsylvania Aircraft Syndicate, Kellett Autogiro Corp., Pitcairn Autogiro Corp., and Glenn L. Martin Co. At Curtiss-Wright Corp., as associate director of the research laboratory, Airplane Division, he engaged in aerodynamic engineering, structures, flight testing, and other experimentation.

Hovgard has had 12 years' experience as a test pilot, and survived five bad crashes. He was 1946-47 chairman of SAE Buffalo Section, and is an associate fellow of IAS.

## Frank W. Fink

Councilor Frank W. Fink (M '44) has been with Consolidated Vultee Aircraft Corp. since 1935, when he became design engineer in the powerplant

group. After he switched to the aerodynamic section, he worked on such vital wartime projects as the Model 31 flying boat and the XB-24 bomber. Since the war's end, he has been chief engineer in charge of airline and military airplanes.

Fink joined Curtiss-Wright Corp. (then Curtiss Aeroplane & Motor Corp.) shortly after he got his BS in Mechanical Engineering from the University of Colorado in 1928. At that time he was assistant project engineer on the experimental model of the P-40.

He was 1946-47 chairman of the San Diego Section.



Newly elected councilors for the 1948-49 term are E. E. Husted (right), Paul E. Hovgard (far right) and Frank W. Fink (top right)

# Vice-Presidents

## Arthur L. Klein Vice-President, Aircraft Activity

Arthur L. Klein (M '42) has been active as educator and consulting engineer since receiving his PhD from California Institute of Technology in 1925. As consulting engineer to Douglas Aircraft Co., Inc., he has contributed to the design of all Douglas planes since 1932. He started his consulting activities in 1929 with Jack Northrop, when he designed the Northrop Alpha and Beta.

Klein has lectured on airplane design at the Graduate School of the Guggenheim Aeronautical Laboratory, and now adds to his work at Douglas as an associate professorship of aeronautics at California Institute of Technology.

Author of numerous technical papers, he is one of the country's most brilliant speakers on aircraft engineering, and has served on several SAE technical committees.



## John L. McCloud Vice-President, Materials Activity

John L. McCloud (M '44) has been with Ford Motor Co. since his graduation from the University of Michigan in 1913, with the exception of two years with U.S. Rubber Co. as student and foreman. He started in 1915 as a chemist, and went on to hold ever more responsible positions in the chemical and metallurgical areas of Ford operations. In February of 1946 he was made head of Ford's Department of Chemical Engineering.

McCloud belongs to many technical societies, through which he has published papers on various technological subjects. Besides SAE, he is a member of the American Society for Metals, American Chemical Society, and American Society for Testing Materials. He has held executive positions in these organizations, and has been member and chairman of several SAE technical committees.



## Warren A. Taussig Vice-President, Transportation & Maintenance Activity

Warren A. Taussig (M '32) is vice-president and general manager of Burlington Truck Lines, Inc. Before joining Burlington, he was general superintendent of Southwestern Transportation Co.

After completing a course in mechanical engineering at the University of Wisconsin, he designed starters and generators for Wagner Electric Mfg. Co. He was a lieutenant of field artillery in the Rainbow Division during World War I, and afterward became assistant editor of Dykes Automobile and Gasoline Engine Encyclopedia, and then an instructor in YMCA auto schools.

During World War II, Taussig worked with both the SAE Ordnance Maintenance Committee and the SAE-ODT Maintenance Methods Coordinating Committee. He has also been active on the T&M Technical Committee and the Sub-committee on Evaluation and Classification of Transportation Engineering Formulas.



## Leslie T. Miller Vice-President, Aircraft Powerplant Activity

Leslie T. Miller (M '37) left Glenn L. Martin Co. in April of last year to become consultant to the Department of Aeronautics at Johns Hopkins University. He had been with Martin since 1939. In 1943 he had become chief powerplant development engineer, responsible for design of engine installations, fuel and oil systems of all new models, as well as liaison with other sections, engine manufacturers, and Army and Navy on engines and technical problems. In 1945 the Propulsion Research and Development Section was created and placed under his direction.

Miller got his BS in ME (Aeronautics) in 1929 from Worcester Polytechnic Institute, and was with Curtiss-Wright Corp. from his graduation until he joined Martin, as test engineer.

He has been a member of SAE Committee A-7 on heat transfer units, acting as NASC liaison from its inception in 1941 until 1946. He was chairman of the Powerplant Activity Meetings Committee in 1947.



# Vice-Presidents



## Joseph B. Armitage Vice-President, Production Activity

Joseph B. Armitage (M '19), vice-president in charge of engineering of Kearney & Trecker Corp. in Milwaukee, has been with the company since 1920, when he was appointed chief engineer. He was born in England, and got his early education there, completing it in the United States. In 1900 he became apprentice draftsman for Brown & Sharpe Mfg. Co. in Providence. In 1904, he entered Rhode Island State College, and returned to Brown & Sharpe three years later as assistant designer. He was associated then with a number of manufacturing concerns until he joined Kearney & Trecker.

Armitage is author of several SAE and ASME papers. He is a member, director at large, and active committee member of ASME, a past-director and member of the Milwaukee Engineering Society, member of the Newcomen Society, and is a past-chairman of SAE Milwaukee Section.



## Harry F. Bryan Vice-President, Diesel Engine Activity

Harry F. Bryan (M '24) has been a carburetion specialist since the early days of the automotive industry, when he worked with Harry Miller of racing car and carburetion fame. After handling heavy fuel carburetion for Moreland Distillate Truck Co., he applied his knowledge to carburetion problems of trucks and tractors in World War I.

After the war, he joined Ensign Carburetor Co., where he later became assistant chief engineer. In 1927 he organized a carburetor division of International Harvester Co.'s Gas Power Engineering Department, and 10 years later was put in charge of combustion research and development. Now research engineer in the mechanical research and development division of International Harvester, he has been active in combustion research of both diesel and carbureted engines. Bryan is a past-chairman of SAE Chicago Section, and was its treasurer for three years.



## Dale Roeder Vice-President, Truck & Bus Activity

Dale Roeder (M '28) is chief engineer of Ford Motor Co.'s Commercial Vehicle Department. He has held this position since 1944, and is responsible for the engineering of all trucks, buses and farm tractors Ford produces.

Roeder served in the Students Army Training Corps after graduation from high school. After the war he got his BS in mechanical engineering from Ohio Northern University, and an MS in automotive engineering from Iowa State College.

He joined Ford in 1925, and for two years did chassis drafting on the Model T. In 1929 he assumed the responsibility of engineering all trucks and commercial vehicles, and in 1937 was made assistant chief engineer of the Ford Division and chief truck and bus engineer. During the war he was engineer in charge of all military wheeled and combat vehicles. He has done considerable work as technical adviser in various patent cases, and has also originated many patents pertaining to commercial and military vehicles and farm tractors.



## George W. Curtis Vice-President, Tractor & Farm Machinery Activity

George W. Curtis (M '32) has been with Timken Roller Bearing Co. since 1920, when he started in the engineering department. He held a variety of positions - principally in the sales department - and in 1938 was appointed manager of the Milwaukee Division, with responsibility for the sales work of the Industrial Bearings, Automotive Bearings, and Steel Divisions. He began his automotive career at 16 as a machinist. During the seven years he was learning tool and die making, he went to night school at Carnegie Institute of Technology, and by 1917 had matriculated in the Institute's School of Science. He returned to his studies after 13 months in the Naval Reserve, and remained until joining Timken.

Curtis has been secretary, vice-chairman, and chairman of SAE Milwaukee Section and has headed many section committees. He has worked with the Tractor Activity Committee since its formation, and at various times has been chairman of its Standards, Membership, and Program Committees.

# Vice-Presidents

## James W. Greig Vice-President, Body Activity

James W. Greig (M '44) is chief engineer for Woodall Industries, Inc. He has held this job since he joined Woodall in 1944. Before that, he was development engineer at Hudson Motor Car Co. He had joined Hudson in 1923, after a few years with a consulting engineering firm.

Greig's education was acquired at Cass Tech, the University of Michigan, and Wayne University.

In 1919 he left Wayne to work as an American engineer with the French Aviation Mission. After the war began his consulting work in the field of automotive and marine engineering.

During World War II, Greig was engaged in a variety of confidential engineering projects for the Navy's Undersea Division.



## John R. MacGregor Vice-President, Fuels & Lubricants Activity

John R. MacGregor (M '29) is associate director of California Research Corp. He had been with the parent corporation, Standard Oil Co. of Calif., since 1925 as a fuel and lubricant test operator, and joined California Research at its formation in 1944.

MacGregor got his BS in mechanical engineering from the University of California in 1923. After graduation he attended the United States Flying School at Brooks Field, Texas, for one year, and then served in the reserves until 1938, when limitations of vision required his resignation.

He has been active on a number of SAE administrative and technical committees as well as in the CFR.



## Wilfred W. Davies Vice-President, Air Transport Activity

W. W. Davies (M '40) has been in air transport engineering for the past 15 years, and is now director of engineering for United Air Lines, Inc. He was engineer in charge when a new world altitude record of 30,000 ft was made in a United Air Lines Mainliner.

Before college, Davies worked at the test laboratories of the Scott Radio organization. While he was at Armour Institute of Technology, he spent his free time in the shops of the National Air Transport Co. After receiving his BS in Engineering, he joined United, and moved through many responsible positions, assuming his present one in March of last year.

Davies is chairman of SAE Chicago Section, and is author of many articles and papers presented before the SAE, AIEE, and ASME, and also of a recently-published book on cargo airplanes.



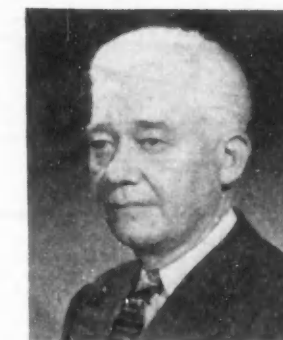
## A. W. Frehse Vice-President, Passenger Car Activity

A. W. Frehse (M '14) is director of the Engineering-Testing Department of Ford Motor Co.'s Engineering Division.

He left the University of Michigan to join the Thomas B. Jeffry Co., now the Nash Division of Nash-Kelvinator Corp., doing passenger car design layout work. During his last year there he worked nights on the first designs of the Jordan car. The Jordan Motor Car Co. was organized in Cleveland in 1916, and Frehse became its assistant chief engineer.

During World War I he served in Washington as member, and later as chairman, of the committee on design of the standardized Class AA military truck. Afterward, as a captain in the Motor Transport Corps, he had charge of engineering of this truck and officer staff cars.

After the war he worked with the Standard Steel Car Co., Reo Motor Car Co., and Chevrolet Motor Division of GMC. He was executive engineer at the Chevrolet Central Office when he left in 1946 to assume his present position with Ford.



# ANALYSIS CLARIFIES of Airplane Engine

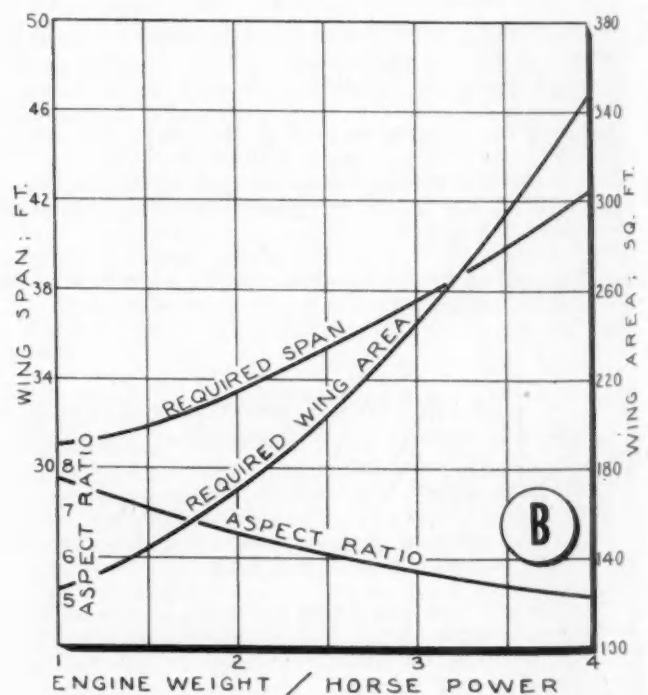
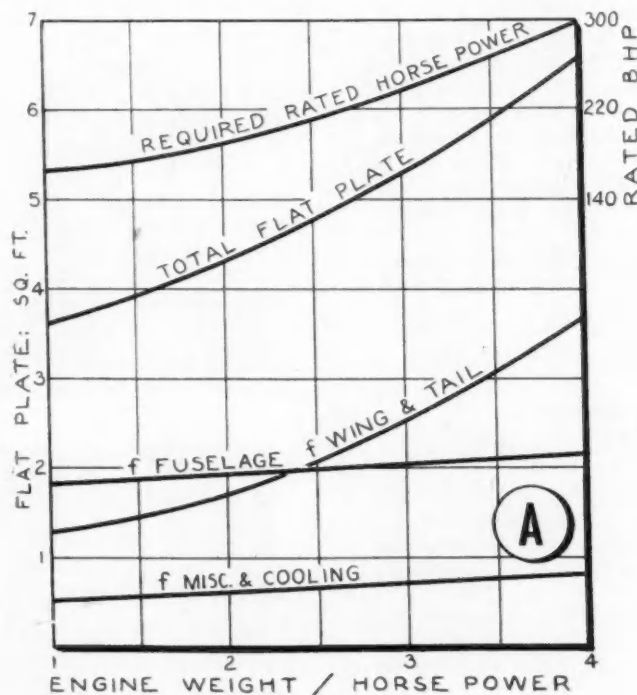
**T**WO of the engine planner's dilemmas – what is the most profitable weight-power ratio to build, and how much is a reduction in engine weight worth in dollars and cents to the airplane manufacturer – can be settled very neatly. The solution lies in considering the economics of the airplane as a whole.

A method has been developed to enable the designer of engines – particularly personal-aircraft engines – to plot a simple graph which will tell him what prices the airplane manufacturer can afford

to pay for engines of various weight-power ratios. The graph shows engine worth in dollars per horsepower versus engine weight in pounds per horsepower. By superposing this curve of worth on a corresponding curve of cost, the engine builder can see what range of engine weight per horsepower will bring him the greatest profit. And when he has chosen the approximate weight-power ratio of his projected engine, the worth curve will give him a rough idea of the value a specific weight-saving detail will add to his design.

To plot this curve, the worths of a number of hypothetical engines are evaluated in terms of the price of an engine of known characteristics. Both

\* Paper "Future Power for the Personal Airplane," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1947.



# ECONOMICS

## Weight

BASED ON A PAPER\* BY

**JOHN W. THORP**

President, Thorp Aircraft Co.

the actual engine and the hypothetical engines are assumed to be installed in airplanes designed to meet a given set of specifications. The hypothetical engines vary in weight-power ratio.

Airplanes for both the actual engine and the hypothetical engines are proportioned, and their costs estimated. Then, for each hypothetical engine, the airplane-less-engine cost is subtracted from the airplane-including-engine cost of the plane using the actual engine. The difference represents the worth of the hypothetical engine. Finally, worth per horsepower can be plotted against weight per horsepower for each hypothetical engine.

Before the analysis is begun, the designer must select a typical set of specifications and a reference engine. The results of the analysis will hold only for the assumed specifications. If a broader picture is desired, the analysis must be carried through for several sets of specifications. The engine chosen for reference should be one of the best available for the service indicated by the specifications. Otherwise the worth of the hypothetical engines will be exaggerated.

A typical set of specifications might call for a 4-place "utility" airplane which will cruise 150 mph at 75% power for 4 hr with 100 lb of baggage and four passengers. The airplane is required to take off in 300 ft, the power-off minimum sinking speed is not to exceed 600 fpm, and the maximum rate of climb must be at least 1000 fpm. (All performance specifications are for sea-level conditions in standard air.)

The airplane is to have a constant-speed propeller - tip speed can be assumed to be 800 fps at rated rpm for the calculations of propulsive characteristics. The engine cooling system shall be considered a part of the engine as far as weight and cost are concerned.

The airplane is to have slotted flaps. Its landing gear shall be of the retractable tricycle type.

### Analysis Has Five Steps

The computations for the analysis fall into five steps:

1. Determine the size, weight, and wing proportions of an airplane which will satisfy the operat-

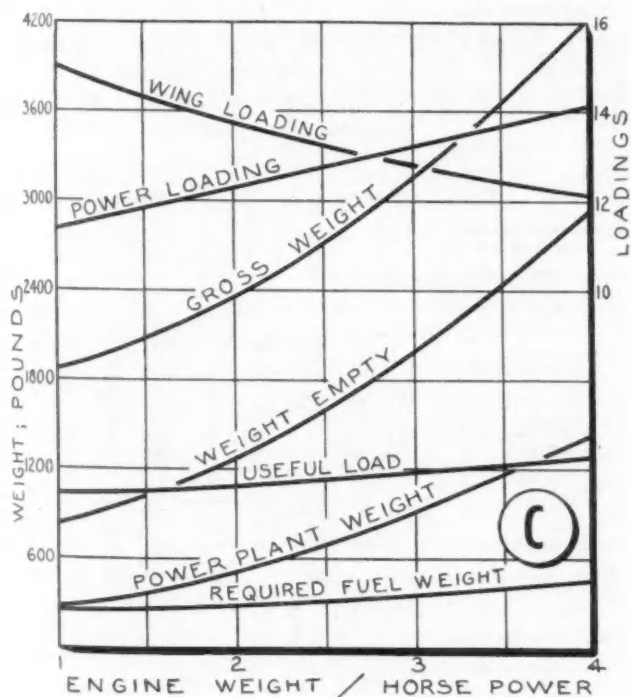


Fig. 1 - Plots developed for Step 3 of the analysis - design of airplanes for hypothetical engines

- A - Flat-plate area and required power
- B - Wing proportions
- C - Weight and loadings

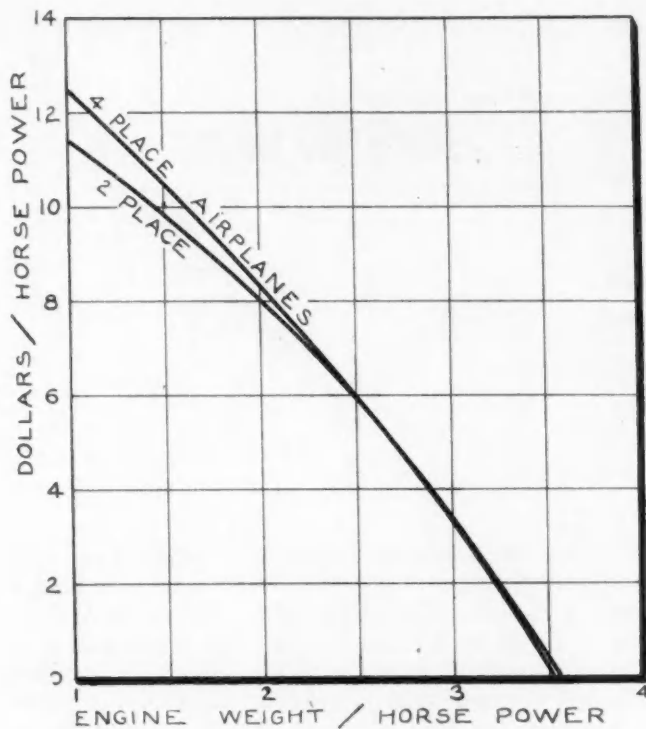


Fig. 2 - Plot of worth per horsepower versus weight per horsepower

ing characteristics specified, using an actual engine of known characteristics.

2. Estimate the cost of the airplane proportioned in Step 1.

3. Design an airplane for each of the hypothetical engines, repeating the processes of Step 1.

4. Estimate the cost of airplane-less-engine for each airplane proportioned in Step 3.

5. Determine the worth of each of the hypothetical engines by subtracting the cost of its airplane as determined in Step 4 from the cost of the airplane-including-engine as determined in Step 2. The "worth" is actually the price that the airplane manufacturer can afford to pay on the basis of the price he pays for the reference engine.

**Step 1 - Determining the size, weight, and wing proportions of the airplane using the reference engine will involve enough rough layout work to ascertain cabin size and other factors which influence gross weight. When weight has been determined, wing area can be calculated by the designer's favorite method. Wing span can be determined by first calculating the span necessary to satisfy the minimum power-off sinking-speed requirement**

<sup>1</sup> See SAE Journal, Vol. 55, August, 1947, pp. 68-69: "2 Ways to Match Wing and Weight" based on papers by H. H. Cherry and A. B. Croshere, Jr., and by J. E. Steiner.

<sup>2</sup> See SAE Quarterly Transactions, Vol. 2, January, 1948: "Approach to Analytical Design of Aircraft," by H. H. Cherry and A. B. Croshere, Jr.

<sup>3</sup> See SAE Quarterly Transactions, Vol. 1, October, 1947, pp. 650-661: "Effect of C.A.R. Performance Requirements on Airplane Design," by John E. Steiner.

and then by checking the climb requirement. Whichever span is greater is the required span. (Several methods which might be useful in Steps 1 and 3 have been or are to be published.<sup>1, 2, 3</sup>)

Airplane cleanliness does enter into the span requirement; but for a family of airplanes, like the family to be calculated for the analysis, this effect is constant. The span is largely dependent upon weight and specified minimum sinking speed or climb.

**Step 2 - The estimate of the cost of producing the airplane just proportioned in Step 1 must be made on the basis of some reasonable assumed rate of production. The cost may be considered to be composed of purchased items, raw materials, direct labor, and overhead.**

An airplane was designed for the set of specifications mentioned above, and its cost was estimated to be \$4463, as noted in Table 1.

**Steps 3 and 4 - It is necessary to assume several hypothetical engines whose weight-horsepower ratios bracket the ratio of the actual engine used in Step 1. Power ratings also must be set for the hypothetical engines. Then an airplane must be proportioned for each hypothetical engine, as was done in Step 1 for the reference engine - here's where the bulk of the work lies.**

The cost of each airplane must be estimated as it was in Step 2.

No simple method is available for working out these steps. Fortunately, some of the factors will be the same as they were in Step 1. It may take considerable juggling to align all the factors to meet, but not exceed, the specifications. Usually the second or third approximation will satisfy all requirements.

The three charts in Fig. 1 apply to four airplanes designed for Step 3 and meeting the sample specifications. Weight-horsepower ratios of 1, 2, 3, and

Concluded on page 46

Table 1 - Determination of Engine Worth

Airplane Using Reference Engine		Total Factory Cost (from Step 2)								\$4463
Airplanes Using Hypothetical Engines,		1		2		3		300		
Engine Weight, lb per hp		165		190		239		300		
Engine Rated Power, hp										
		Cost,	Wt.,	Cost,	Wt.,	Cost,	Wt.,	Cost,	Wt.,	
		\$	lb	\$	lb	\$	lb	\$	lb	
Purchased Items		250	40	250	40	250	40	250	40	
Instruments, radio		225	35	250	40	370	60	480	80	
Propeller		117	39	141	47	198	66	240	80	
Powerplant accessories		120	40	135	45	165	55	210	70	
Wheels, tires, brakes		120	40	180	60	180	60	180	60	
Electrical, hydraulic equipment		100	20	150	30	200	40	250	50	
Accessories		200	100	200	100	200	100	200	100	
Furnishings, miscellaneous										
Totals		1132	314	1306	362	1563	421	1810	480	
Engine			165		380		717		1200	
Raw Materials		346	346	518	518	854	854	1272	1272	
Weight Empty			825		1260		1992		2952	
Direct Labor		454		519		613		700		
Overhead		477		546		645		751		
Total Factory Cost (less engine), \$		2409		2889		3675		4533		
Engine Worth (= \$4463 - factory cost), \$		2054		1574		788		-70		
Engine Worth per Horsepower, \$ per hp		12.46		8.29		3.30				

# NEW CARS Feature Rebirth of Yesteryear's Originals

BASED ON PAPER\* BY

**Harold T. Youngren**

Vice-President and Director of Engineering and Research,  
FORD MOTOR CO.

**M**ANY seemingly current car innovations stem from early 1900 ancestry. They were kept under wraps until necessity for them ripened.

Illustrations on the following two pages spot just a few such examples. These and other engineering creations worked their way into cars on

\* Paper "Passenger Car Design—A Review," was presented at SAE Detroit Section, Oct. 6, 1947.

the modern assembly line only when a need for them arose. Some will continue gathering dust on the shelves until changing conditions make them a must.

You may look at pioneering automobile developments and ask, "Why did most manufacturers wait almost 40 years before adopting the steering-wheel gearshift?" First, their design was immature. Second, the "wobble stick" was simpler and cheaper.

Right-hand drive in early cars prompted their use. Gearshift levers and handbrakes interfered with getting in and out of the driver's seat. The shift to left-side steering eliminated this need. Other reasons for their abandonment were: the

## Need Shapes Car of Future

Changes in use are redesigning the coming car. New shape, engine design, styling, and mechanical aids will reflect these demands, predicted Youngren in his paper on which this article is based.

He pointed out that, in its original form, the car was designed to carry people. Now it serves as a carrier for both people and things. The farmer trucks his milk cans, butter, and eggs. The city dweller transports his family and baggage on long trips. Commuters shop. Sportsmen hunt, fish, and golf. All use their cars for these and thousands of other activities.

More and more the car is becoming a "living room on wheels." That spells wider, roomier cars with ample baggage space.

The trend is for compactness of the engine package. For this reason and

because they offer accessibility and design simplicity, the V-8 and horizontal-opposed or pancake engine will become increasingly popular.

As cruising speeds go up, need for good aerodynamic design increases. Smooth, flowing lines are a must. Fortunately good aerodynamic design enhances beauty. Functional and aesthetic needs require better styling.

New mechanical devices are on the way, too. Greater front-end weight of larger cars already hampers steering. Eventually luxury models will feature auxiliary steering aids. Here cost, not technical problems, is the biggest factor.

Because the average car renders year-round service, need for greater comfort takes on prominence. Engineers aim to satisfy this growing requisite with fully automatic transmissions, more comfortable seats, better ventilation, improved visibility.

too-great motion range of the single sliding member and the shifting difficulty with a very short lever – particularly in cold weather. This gave rise to the off-the-floor gearshift.

But as the automobile became a handy device for running errands and pleasure driving, women took an interest in driving. They didn't share man's enthusiasm for showing off his gear-shifting ability without clashing. The need for something simpler gave birth to the synchro-mesh transmission. Need for more front compartment space sent the gearshift lever back to the steering column. Maybe this time it's for good, or as long as manual gearshifting remains.

### Modern Suspensions Dated

American motor cars have also run the gamut of spring suspensions. The torsion bar and individual wheel suspension were favorites of European designers many years ago. The torsion bar is confined to few American trucks. But only in 1934 did American car builders adopt the individual wheel suspension.

Until that time motorists used their cars mostly for comparatively short jaunts. And women weren't driving much. (Today they are a salient factor in car design.) Now the automotive engineer has been alerted to the ever-growing need for better ride. He's doing something about it.

The 1913 Scripps-Booth Cyclecar is another forerunner of a much-discussed subject – the light car. This vehicle was a snappy performer. A number were sold. They enjoyed brief popularity. Then as now many said they wanted a good light car. But sales records proved the public preferred a second-hand full-size car to a new light, small one.

### Early Aluminum Car

In this regard aluminum has been proposed as a replacement for "king steel." Back in 1923 Pierce-Arrow and Aluminum Co. of America jointly produced an aluminum car. This 85% aluminum vehicle weighed 3,045 lb despite its 133-in. wheelbase. A stock model Pierce-Arrow of comparable size weighed 3,730 lb.

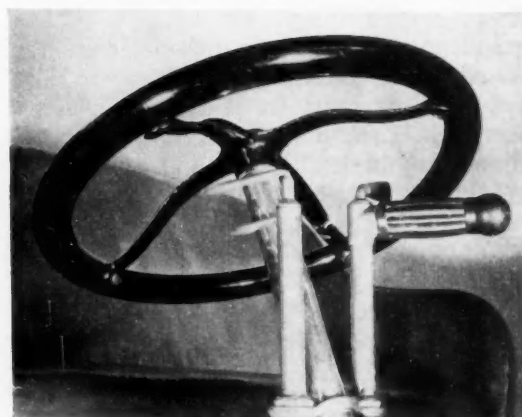
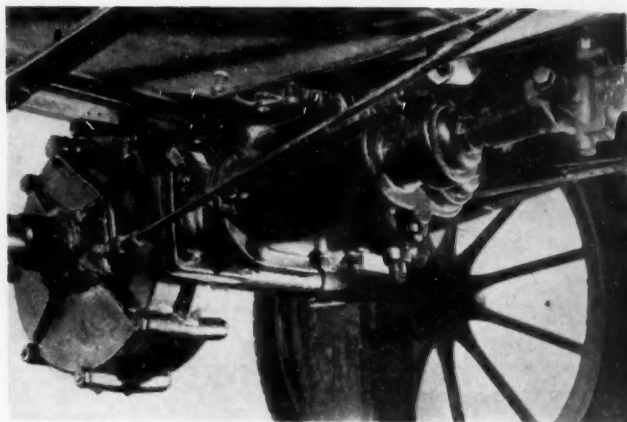
Its 3¼-in. bore, 5-in. stroke engine developed 75 hp. It had aluminum cylinder heads, cylinder block, crankcase, and oil pan. Pistons, connecting rods, and chain case cover were aluminum.

The conventional transmission was cased in aluminum. Pressed sheet aluminum formed the frame. Forged aluminum was used for front axle, steering arms, brake levers, and wheels – including drum and hub. Aluminum even went into the rear axle, torque tube, body doors, and radiator.

Several of these cars ran up to 100,000 miles without giving serious trouble.

Yet we don't have aluminum cars today. Why? Because the need for lower cost far exceeds that

## What's New Under



The 1904 Covert Chainless was one of the first to use a fully-enclosed bevel-gear rear axle similar to modern designs. It also featured a rear axle mounted transmission. And 44 years ago drivers of this car used a steering-post gearshift mechanism

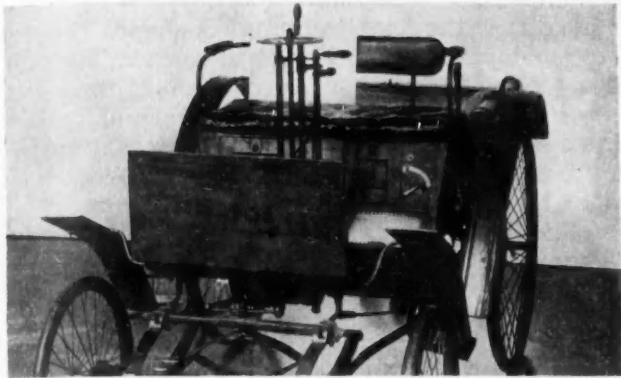
for lighter weight. Current use of aluminum is a temporary expedient. The steel shortage together with a need for sustained production prompts all car manufacturers to explore every possible use of aluminum. It costs more money, but saves steels and builds more cars.

The four-wheel brake is another case in point. Racing cars used good mechanical brakes 25 and 30 years ago. Four-wheel brakes were available at least 10 years before their adoption. But two-wheel brakes were adequate for low speeds and light traffic.

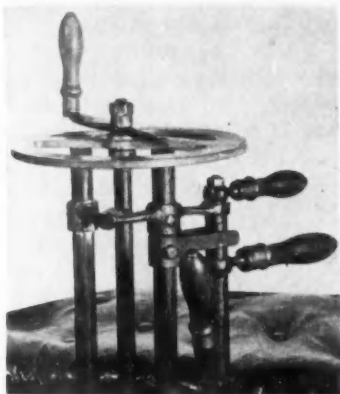
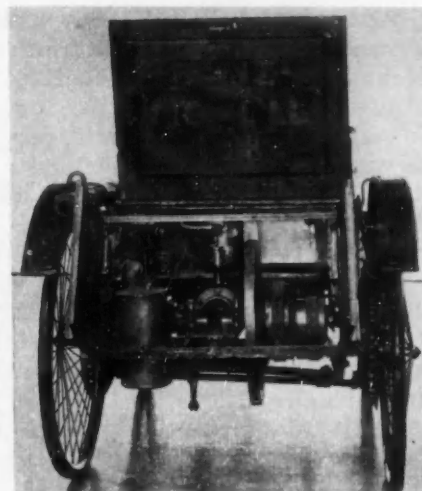
Advent of faster cars, better roads, heavier traffic, need for quicker deceleration and longer brake life changed this picture. These conditions warranted four-wheel brakes.

Another feature considered from time to time is

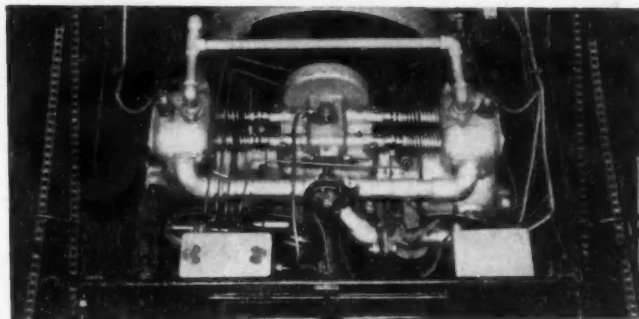
# Automotive Sun?



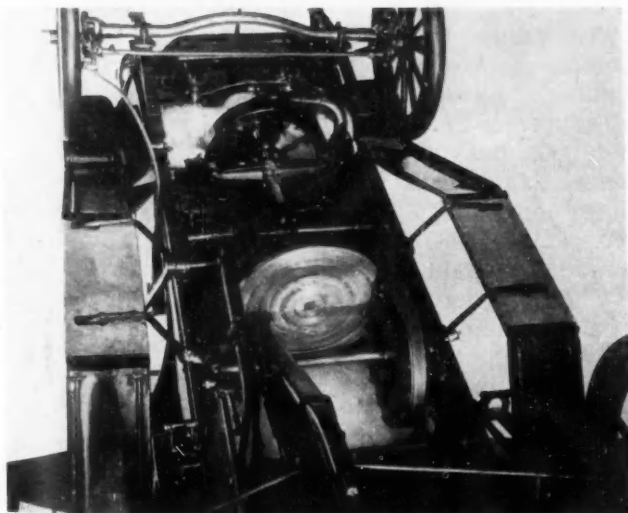
Here's a rear view of that same 1888 model Benz. It also stole the march on present-day advocates of the rear-engine installation. This car had one



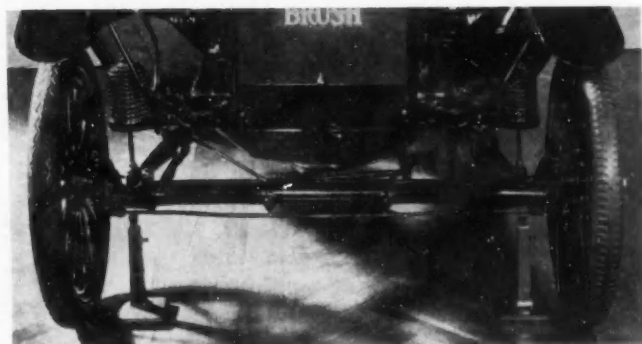
Back in 1888 Benz brought out this buggy-like contraption. Recognize the gearshift lever on the steering column? It's enlarged at left



There's nothing new about the light horizontal opposed-type engine. This engine in a 1909 Schact demonstrated the accessibility, compactness, and design simplicity of this type long before current light-plane experience



Item in today's car engineering limelight—the automatic transmission—was achieved nearly four decades ago. This underside view of a 1909 Carter shows an infinitely variable transmission. These early engineers obtained an unlimited variety of unlimited engine-to-axle ratios by moving the friction disc across the flywheel face. The transmission was standard equipment on this \$1150 car



This 1910 Brush featured coil springs all the way round. A close up with the front wheel removed shows the axles positioned by a unique combination of shock absorbers and radius rods

front-wheel drive. A French steam-propelled contrivance built in 1769 had a front-wheel drive. And around the turn of the century Walter Christie pioneered front-wheel drive for gasoline engine-powered cars. He mounted the engine transversely between the wheels, coupled directly to the crankshaft. It flourished in Europe where low production and no concern over mass acceptance give greater experimental latitude.

Front-wheel drive like the rear-engine drive offers some interesting possibilities. Both give low overall height and potential weight saving. Both are ever-present possibilities should the need for such vehicles arise.

Early automotive design engineers who created these devices could afford the luxury of trying them on the public. They had no tremendous tooling costs to contend with. Small production required no elaborate tools. They could experiment at will, change designs with little inconvenience. Today's vehicle designer enjoys no such advantage.

Mass production and standardized service rule out such practices. The manufacturer cannot afford to guess wrong on new model changes. Once he makes up his mind, there's no turning back - not if he's to meet close schedules.

After changes based on needs of the public are

funneled to the design engineers, the drafting-board-to-production-line process takes two years. That's the time it takes to make most major changes.

Hand-making the models, dynamometer testing, road workouts under extreme conditions then follow for each new part. This process compiles volumes of engineering data - all to be digested and evaluated.

Gradually the final design takes shape. The production department then goes to work building the dies, tooling, fixtures. The procurement group goes into high gear organizing its network of vendors into a smooth-working team. Thousands of parts - from nuts and bolts to whole assemblies - must reach the plant at the right time.

Millions of dollars are poured into this finely-balanced industrial machine to ready it for the mass car production job. Only one premise justifies such expenditure of manpower, time, and money: the design engineer created a new device the public needs. This responsibility rules out any temptation to gamble or experiment. The investment is too great, the consequences of failure too serious.

But if the engineer gives the public what it needs, not what he wants, chances of market reception are infinitely better.

## ANALYSIS CLARIFIES ECONOMICS

Continued from page 42

4 were assumed. The cost estimates appear in Table 1.

*Step 5* - All these airplanes will be about equally useful because they have been designed to do the same job. Therefore, the designer can assume that they will all command the same price. If they are to command the same price and yield the same profit, then manufacturing costs must be equal.

That means that cost of airplane-less-engine plus cost of engine will equal a constant - the constant being the cost of the reference airplane including engine, or \$4463 for our example. The worth of each hypothetical engine can be found by subtracting the cost of its airplane-less-engine from the constant.

This procedure has been followed in Table 1 for the example.

When worth has been computed, all that remains to be done is to divide worth by horsepower and plot the dividend against weight-horsepower ratio. Fig. 2 shows the plot for the example and also the results for calculations on a 2-place airplane for somewhat similar specifications.

The assumption in Step 5 that the airplanes will command the same price ignores the fact that lighter engines in lighter airplanes are more desirable from the handling standpoint. On the other hand, the heavier engines will probably have lower maintenance costs. Replacement parts and replacement engines will cost less; and, because specific output is lower, longer periods between overhauls and longer engine life can be expected.

The designer's last step is to estimate the cost of the various hypothetical engines and plot cost in dollars per horsepower versus horsepower-weight ratio. Then he can compare cost and worth curves to see what value of weight per horsepower he should design for, in order to make the greatest profit.

The airplane manufacturer probably will not be content to let the engine builder keep any large margin of profit, but both builder and manufacturer cannot help but benefit from the results of designing closer to the optimum. The analysis offers a good check that the design is not fundamentally unprofitable.

# DECIMAL DIMENSIONING CONVERSION

## Painless for Aeronautic Industry

BASED ON A PAPER\* BY

**O. E. Kirchner**

DIRECTOR OF ENGINEERING,  
AMERICAN AIRLINES, INC.  
and Chairman of SAE Committee S-1,  
Aeronautical Drafting Manual

**A**Doption of decimal in place of fractional dimensions meets with little employee and vendor resistance and creates no transitional snarls. This was the consensus of opinion of 75% of the aeronautic industry, now using decimal dimensioning, in a recently-conducted survey.

Most people involved in the changeover accepted decimals without opposition; others "got religion" after seeing the system in action. The survey unveiled no costly or serious disruptions during the switch from fractions. While methods of introducing decimal dimensioning into company operations varied, satisfaction over results was close to unanimous.

### Favored by Most

In every case engineering department personnel were 100% for the change while at least 90% of those in the shop favored it. Others showed some resistance but accepted it gradually.

One company reported, "At first the shop rejected the plan; on second try, after some experience, it favorably accepted same." In another case we found a house divided - the machine shop preferred decimals but the sheet metal shop favored fractions. Another company reported, "Some old timers will never be convinced."

About 10% of the decimal dimensioning users found some resistance among subcontractors, vendors, and suppliers. Especially was this true of forging and casting vendors since they had no decimal shrink scales. One 12-year user of the decimal system discovered that his forging sup-

plier redrew each drawing for four years before finally accepting the manufacturer's drawing for direct use.

It's interesting to note that companies experiencing difficulty with outside vendors are recent converts to decimal dimensioning. Companies using the system for more than three years have now forgotten any difficulties they may have had with suppliers.

Comparison of errors with that of the old system is usually an index to workability of the newly-instituted procedure. No decimal-using company expressed any concern over this point. In fact the general feeling was that accuracy had improved.

### Individual Troubles Temporary

In isolated cases personnel had trouble thinking in terms of decimals instead of fractions. But this was only a transitional problem and not one that would contribute to dimensional errors. One manufacturer said that some old timers did not recognize 0.25 as being the same as 0.250 or  $\frac{1}{4}$  in.

Ease of new employee assimilation may be considered another measure of success of any engineering and shop procedure change. No troublesome case was reported in this area. Each new employee accepted the new system as part of his

\* Paper "Decimal Dimensioning - What Profit?" was presented at the SAE National Aeronautic Meeting (Fall), Los Angeles, Oct. 4, 1947.

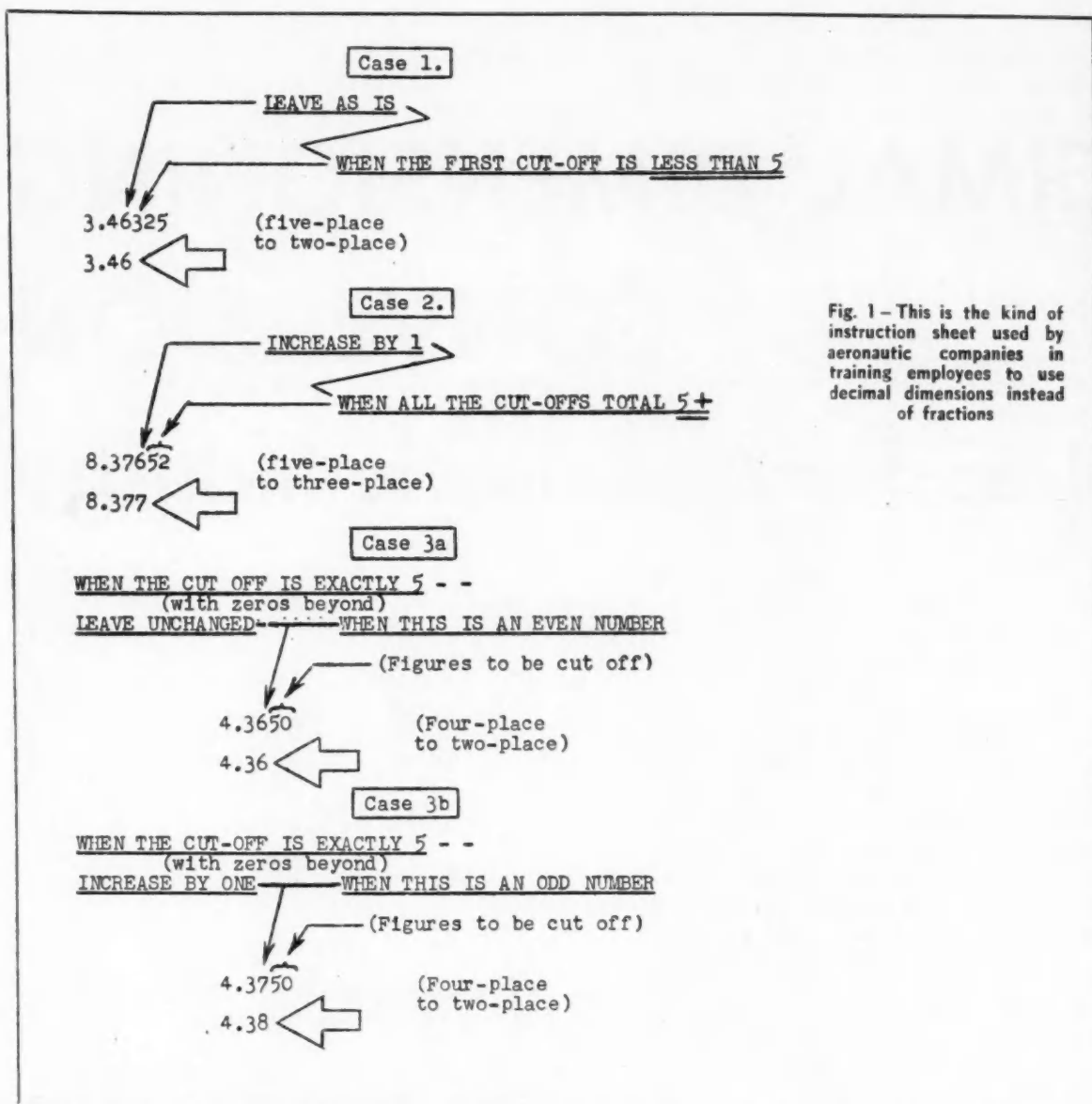


Fig. 1 - This is the kind of instruction sheet used by aeronautic companies in training employees to use decimal dimensions instead of fractions

indoctrination. Personal difficulties, if any, were apparently self-corrected.

#### Types of Training

The question referring to degree and type of instruction preceding the switch to decimal dimensioning brought the greatest variety of answers. Pre-decimal training ranged from "just changing the drafting manual" to "lectures, magazine articles, and verbal publicity." Most issued detailed instructions along with the change noted in their particular drafting manuals. Fig. 1 shows a typical instruction sheet. Others distributed conversion tables to all employees affected.

Judgment and understanding of the chief or supervising engineer and the shop superintendent

can greatly ease the familiarization process for their personnel.

One company even formed a committee with

Table 1 - Use of Decimal Dimensioning in the Aeronautic Industry<sup>1</sup>

	Use the System	Use the System 100%	Partially Use the System
Engine Makers	88%	83%	17%
Propeller Makers	80%	100%	...
Aircraft Makers	72%	65%	35%
Accessory Makers	70%	40%	60%
Airline Operators	67%	25%	75%

<sup>1</sup> See "Extent of Decimal Dimensioning Probed by Aero Drafting Group," October, 1946, SAE Journal, pp 81-83, and "80% of Aero Industry Favors Decimal Use," March, 1947, SAE Journal, p. 82.

representatives from each department to study the effects of such change prior to making it. This group released instructions covering all conceivable engineering complications that might arise. For any company anticipating some department's resistance to the change, the committee plan is probably the best and most orderly method.

Type of product manufactured by the company has some bearing on method of conversion. Makers of large units - such as airplanes - started the system on new projects only. This eliminated redrawing of old drawings. In fact this procedure was common for most companies.

#### Old Drawings Redimensioned

Others made the system retroactive as of some effective date. In these cases several methods of reworking old drawings were used. One manufacturer ruled that if more than 50% of any old drawing had to be redone, the new system should be used. Size of drawings influenced the method too. But most companies changed old drawings when they had to be redrawn. One manufacturer voiced the plan of many when he said, "We just let nature take its course. It took about two years in our case."

Not one manufacturer concerned himself with use of both systems during the conversion. All reported that both systems could be used interchangeably in the shop. Some favored a gradual change to help acquaint personnel with decimal dimensioning merits. Older users found the complete change-over to require two to four years.

Extent to which some companies have gone to decimal dimensioning varies from complete acceptance to exceptions when referring to bolts, rivets, cable angular dimensions, thread sizes, and materials procurable only in fractional sizes. Table I shows the breakdown of industry use of decimal dimensioning.

#### Possible Expense Item

Obsolescence of drafting and tracing paper stocks with imprinted fractional tolerances is a possible nonproductive cost incurred by the change. Survey returns showed most companies had not been calling out fractional tolerances and had no problem. All others except two just overmarked the fractional tolerances with decimal tolerances. The two exceptions scrapped small quantities of printed stock.

Such preponderance of satisfactory experience should readily convince one of the ease of switching from fractions to decimals.

An interesting byproduct of this investigation comes out of the sample drafting procedure sheets sent in by some of the companies. They show much need for drafting standardization. A big job still lies ahead of SAE Committee S-1 in the development and promotion of sound, uniform drafting practices.

## 47 Decimal Dimensioning Users

Survey on the use of decimal dimensioning in the aeronautic industry by the SAE Aeronautical Drafting Manual Committee disclosed the following companies as users of decimal dimensions. If any other company contemplates conversion to the SAE decimal system, undoubtedly any one of these manufacturers will answer any questions.

1. Aeronca Aircraft Corp.
2. Air Associates, Inc.
3. Aluminum Industries, Inc.
4. American Bosch Corp.
5. American Tube Bending Co.
6. AVco Mfg. Corp., Lycoming Division
7. Bendix Aviation Corp., Scintilla Magneto Division
8. B.G. Corp.
9. Boeing Aircraft Co.
10. Borg-Warner Corp., Detroit Gear Division
11. Breeze Corporations, Inc.
12. Camloc Fasteners Corp.
13. Candler-Hill Corp.
14. Columbia Aircraft Corp.
15. Consolidated-Vultee Aircraft Corp.
16. Curtiss-Wright Corp., Airplane Division
17. Curtiss-Wright Corp., Propeller Division
18. Dumore Co.
19. Eastern Airlines, Inc.
20. Eaton Mfg. Co., Wilcox-Rich Division
21. Elastic Stop Nut Corp. of America
22. Electronic Laboratories, Inc.
23. Engineering and Research Corp.
24. Evans Products Co.
25. Flottorp Mfg. Co.
26. Holley Carburetor Co.
27. Jacobs Aircraft Engine Co.
28. Lockheed Aircraft Corp.
29. Luscombe Airplane Corp.
30. Marlin-Rockwell Corp.
31. National Airlines, Inc.
32. Northeast Airlines, Inc.
33. Pesco Products Co.
34. Ranger Aircraft Engines
35. Republic Aviation Corp.
36. Searle Aero Industries, Inc.
37. Shakeproof, Inc.
38. Simmonds Aerocessories, Inc.
39. Solar Aircraft Co.
40. Specialties, Inc.
41. Spencer Thermostat Co.
42. Sperry Products, Inc.
43. Transcontinental & Western Air, Inc.
44. United Aircraft Corp., Chance Vaught Aircraft Division
45. Western Airlines, Inc.
46. Weston Electrical Instrument Corp.
47. Wright Aeronautical Corp.

**P**NEUMATICS is the best method of actuating aircraft accessories that operate intermittently, at high speed, or under heavy load, according to the authors.

In justification, they present the following accomplished facts for the pneumatic system of the XB-46, a 93,000-lb, 4-jet-engine bomber with tri-cycle landing gear:

1. Landing gear retracts into the nacelle in less than 4 sec - the first big plane to fly successfully that can retract its gear in so short a time.
2. Bomb doors operate in 1 sec.
3. Brakes operate smoothly, can be applied or released instantly at all operational temperatures.

#### Advantages of Pneumatics

There are many advantages to operating such accessories by air, the authors claim, for instance:

1. It offers the least total weight per delivered horsepower.
2. It takes the least amount of power from the

# Split-Second Operation Claimed

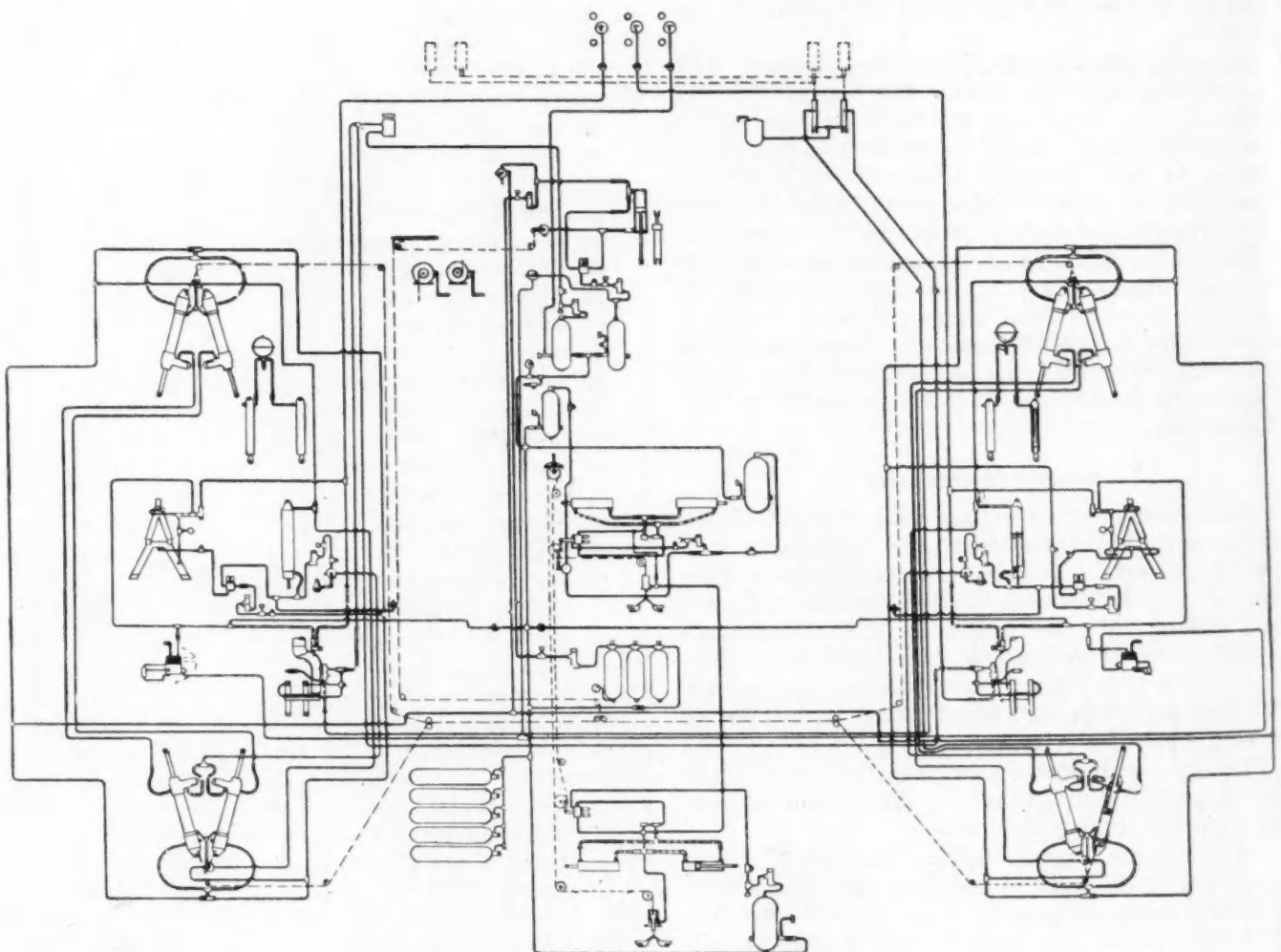


Fig. 1 - Schematic diagram of pneumatic system for landing gear and bomb-door operation

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# d for Pneumatics

BASED ON A PAPER\* BY

**Howard F. Schmidt**

and

**H. F. Gerwig**

CONSOLIDATED VULTEE AIRCRAFT CORP.

engines, which is important not only when the plane is taking off, but it is also a fuel saver, because its potential energy is stored by ground charging, and it need not be restored unless more than two complete cycles of operation per unit are required.

3. Air is always available, and at no initial cost.
4. It is free from fire hazard.
5. When a leak occurs it is easily detected by the sound of the escaping air, which, incidentally, creates no mess.
6. It is ideal for extreme winter or summer operation:

(a) The small-diameter lines sufficient for standard temperatures are satisfactory even at -65 F, because at this temperature the viscosity of air is still very low.

(b) Unlike viscid fluids, air does not congeal, and the freezing of moisture deposited in the accumulators, originally considered a problem, has proved of little consequence, as the air delivered from the ground-charging compressor is practically dry and an engine-driven compressor deliver-

ing 5 cfm of free air at 1500 psi discharge pressure would collect only 5.77 cu in. of moisture, even under the most humid conditions, in the 12 min it operates per flight, as compared with a system volume of 7000 cu in.

(c) Pressure loss due to line friction is very small over the operating temperature range.

(d) Serious shock waves due to surge pressures do not occur because air is a compressive medium.

7. When an actuating cylinder is employed, air makes an ideal cushion to arrest the high-speed motion of the piston.

8. When the air storage pressure is at least twice that of the operating pressure, sonic velocities are reached, so the units can be designed to operate in a fraction of a second, if necessary.

## **XB-46 Pneumatic System**

Fig. 1 shows diagrammatically the pneumatic system for the landing gear and bomb-door operation of the XB-46. The system is composed of the following:

1. Accumulators or storage bottles: In these units air is stored at 1500 psi to provide potential energy for a minimum of two cycles of operation without recharging. The units are charged on the ground by a service compressor of high capacity and are maintained in flight by a low-capacity, engine-driven compressor.

2. Compressors: The most practical compressor so far developed is an engine-driven, 2-stage piston type that delivers 5 cfm of free air at a discharge pressure of 1500 psi. It is small and compact, weighing only 15 lb.

3. Pressure regulators: These units reduce the storage pressure to the required operating pres-

\*"Why Pneumatics? Or the Case for Pneumatics for Intermittent Services on Aircraft" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1947.

sure, thereby conserving storage energy and saving considerable weight by eliminating the necessity for all units and lines to withstand storage pressure.

The most satisfactory type now available is the optically flat, lapped-plate poppet type.

4. Relief valves: These units protect the system from rupture due to surge pressure or failure of the regulator. There are several available, of which the diaphragm spring type is the lightest. This type, however, has a tendency toward fatiguing of the diaphragm after repeated operations. A more satisfactory valve is being developed.

5. Selector valves: These units control the operation of all actuating units. There are basically three methods of operating them: (a) pilot control by pneumatics or hydraulics, (b) electric solenoid control, and (c) manual control.

So far the "shear flow" type is the most satisfactory valve developed. It embodies the principle of an optically flat, lapped tubular poppet and slide or rotor seat. Unlike other types, where the poppet is lifted off the seat to provide flow, the tubular poppet is moved along the seat. It wipes off the seat as it moves, thus tending to shear off any ice forming on it.

6. Actuating units: These units provide the force required to move the parts to be operated. There are two basic types: (a) actuating cylinders with linear motion, and (b) air-driven motors with rotary motion.

Pneumatic actuating cylinders are basically like hydraulic ones except that integral lubrication is required. This is accomplished at present by installing a grease-packed felt washer in a groove on both sides of the standard rubber "doughnut" seal. Air motors to be operated at high pressures are still in the development stage, but they undoubtedly will prove satisfactory and save weight over the electric motor, especially in such applications as flap drives.

7. Brake valves: These units regulate the pressure delivered to the brakes, thereby controlling the rate at which the airplane is stopped.

The most economical brake valve installation is achieved by mounting the valve itself on the main landing gear and controlling it through the foot pedals by means of a remote control, self-contained, hydraulic master and slave system.

Because the landing gear itself can be used as an accumulator, very short lines are used to deliver air to the brakes. In addition, the exhaust air is vented at the valve, thus effecting split-second operation.

The most satisfactory brake valve again embodies the principle of the optical-flat lapped-plate

#### Research Problems

The development of this pneumatic system was not without difficulties. The authors point out that research is needed along the following lines:

1. Seals: Although initially externally lubricated, the rubber seal expands, forcing the lubricant from between itself and the cylinder wall. The rubber then tends to bond itself to the wall and, dependent on the piston size, may require a force up to 500 lb to break it loose, even in hydraulic systems. The cure is either a permanently impregnated lubricant in the rubber seal or a metal seal that is scintered and lubricant induced through the pores. This is feasible, especially in systems subject to intermittent service and not having to maintain continuous pressure.

2. Pressure regulators must be designed with a low rate spring so that temperature changes and a small adjustment do not cause high pressure changes. Regulators all seem to have a high-rate spring, which is ideal for weight saving under normal conditions, but, since the spring is short and stiff, it is sensitive, especially on regulator bodies made of aluminum, so that the differential of expansion is high. They must also be capable of flowing air equivalent to the line size used and have free return flow.

3. Metal diaphragms of relief valves must be capable of repeated cycles without fatigue of the metal.

4. Hydraulic and pneumatic methods of snubbing actuating cylinders at the end of their stroke must be investigated. Of the pneumatic methods tried in the XB-46, the use of a bypass valve in the bomb-door system was the only successful one. This system was based on restricted flow to the opening side of the cylinder and full flow to the closing side. When full operating pressure was reached, the bypass valve closed off the flow and opened the closing side of the cylinder to a restricted exhaust to the atmosphere, which provided an adiabatic cushion on the closing side but ultimately allowed the air to bleed off and the full effective pressure to work to hold the door open.

When large masses and forces are involved, development should be carried out on integral hydraulic snubbing within the pneumatic actuating cylinder itself.

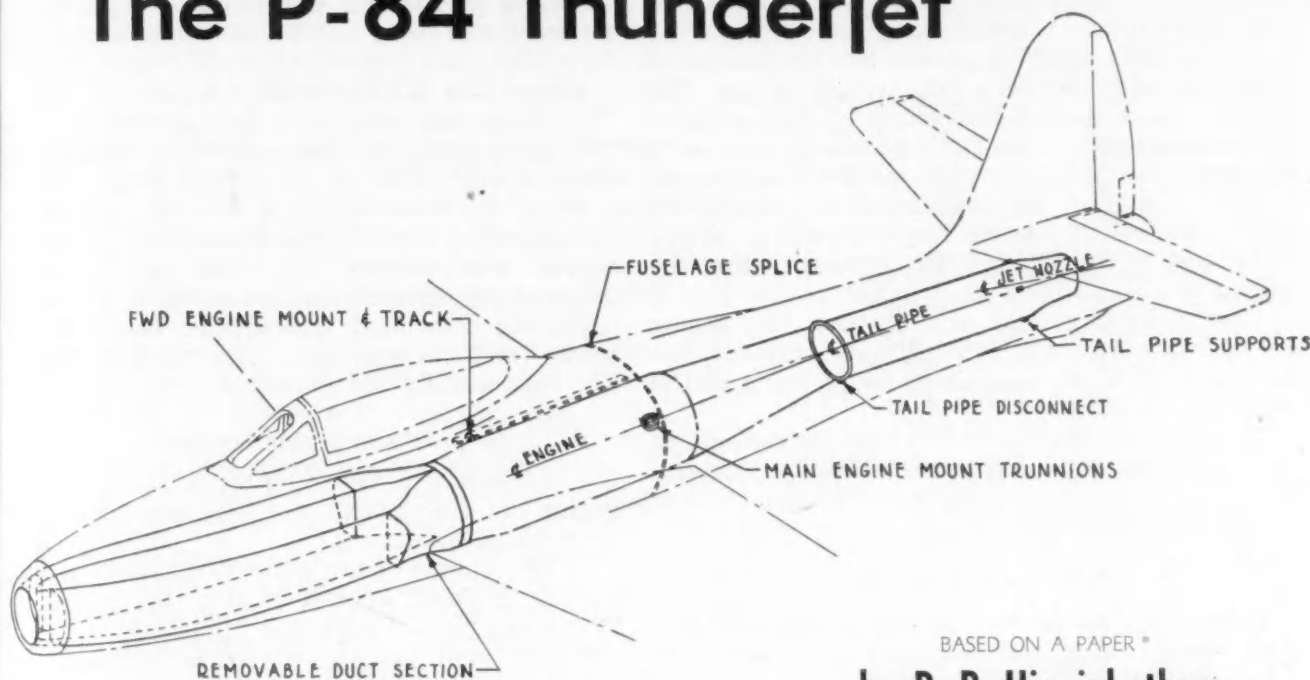
5. Pneumatically operated starters are needed, especially for jet engines, which require ground service battery carts, making starting in remote locations impossible.

6. Pneumatic-driven motors with followup control must be developed for flap, surface control, steering, and the like. It should be possible to build one for about 25% of the weight of an equivalent hp electric motor.

7. Pilot's seat and canopy emergency ejection by pneumatics should be developed.

8. Windshield cleaning not only by pneumatically driven wipers but also by spraying the windshield with fluid by an air-driven jet pump of the venturi type is needed.

# Fitting The TG-180 Turbojet To The P-84 Thunderjet



BASED ON A PAPER \*

by R. R. Higginbotham

STAFF ENGINEER, REPUBLIC AVIATION CORP.

(This paper will be published in full in SAE Quarterly Transactions)

**S**CORES of installation problems were encountered and solved before the TG-180 turbojet drove the XP-84 Thunderjet fighter to set an official American speed record of 611 mph in August of 1946.

A frank discussion of some of the problems may benefit others who must design similar installations. There were the usual major problems of cramming the engine and all its accessories into the small space available—yet providing for easy access and quick engine replacement. At the same time, losses in the long inlet duct had to be held down . . . the tail pipe had to be connected to the engine in a strong, tight joint that would not impose excessive bending moments on the engine . . . the fuselage had to be protected from the heat of the engine . . . a jet nozzle of optimum area had to be supplied . . . oil lines had to be made trouble-free . . .

\* Paper "Engine Installation Problems in the XP-84 Airplane," was presented at a meeting of the Metropolitan Section of the SAE, New York, Dec. 9, 1946. Editing of this paper had to be delayed until it was released by the Army Air Forces.

Lack of space was the primary problem. The configuration of the P-84 was based on the principle that the smaller the airplane, the faster it would be.

Engine air is taken from the stagnation point on the nose of the fuselage into a circular opening which branches into two ducts. The ducts merge into an annulus again just ahead of the compressor inlet.

Splitting the duct provides space for the nose wheel and strut. Two interconnected fuel tanks having a combined capacity of 130 gal are also located between the ducts.

Because the inlet ducts had to be led under the pressurized cockpit, the straightest possible overall path required that the engine be mounted nose down 4 deg with respect to the fuselage axis. Corresponding bends in the tail pipe bring the gas stream back to the axial direction. No adverse effects on stability were expected, because the inertia effects cancel out within the airplane. Flight experience has born out this expectation.

The specifications required that it be possible to change engines in 50 min. With this in mind, the fuselage tail section was designed to be attached

to the main fuselage with four bolts, the parting line being just aft of the engine trunnions. The tail pipe does not have to be removed from the rear of the fuselage to remove the engine.

Engine and tail pipe can be separated by unfastening a quick-disconnect clamp which covers mating V-flanges. A special dolly is available for moving the detached fuselage assembly.

The inlet duct-engine connection is a butt joint sealed by confined hollow rubber rings. This connection requires no unfastening.

Of the three engine supports, two are horizontal trunnions equipped with quick-acting clamps. The third support, located forward at the top, slides in a track attached to the fuselage. Guide rails were designed for the main horizontal trunnions to guide the engine past close clearances during removal and replacement. Experience has shown that these guide rails are not necessary - that the engine can be handled easily by attaching a sling to the main trunnions and drawing the engine rearward, using the top mount in its track for support and guidance until the forward cable of the sling can be attached.

This general installation pattern turned out to be a good answer to the replaceability problem. Actually, one engine can be removed and another put in place in 50 min.

#### Induction System Losses

First worry about the induction system was that duct losses in the 15-ft-long duct would seriously

reduce the static thrust at the start of take-off. It was thought that auxiliary inlets near the compressor might be needed.

Tests of a mockup duct without auxiliary inlets on an actual engine mounted on a thrust stand showed, however, that the loss of static thrust at 7600 rpm was only 4% and the reduction of impact pressure at the compressor inlet was only 1.9%. Then auxiliary inlets were added and more tests run. Thrust loss was cut to 2.9% and impact-pressure loss to 1.5%. The complication of auxiliary inlets is not justified.

Losses due to leakage were much more serious. The ducts had to be fitted with removable panels to permit access to the accessories enclosed between the branches.

When the first design of the rear duct section was pressure tested in the laboratory, the leakage was so severe that the factory air supply could not produce the required test pressure.

Sealing compound was applied to the riveted seams, and fasteners were spaced more closely. The next test showed greatly reduced leakage.

#### Exhaust System Problems

The problem of designing the joint between the engine tail cone and the tail pipe was complicated by three requirements:

1. The engine manufacturer insisted that the bending moment applied to the engine tail cone by the tail pipe be kept to a minimum.
2. The joint had to be able to withstand the

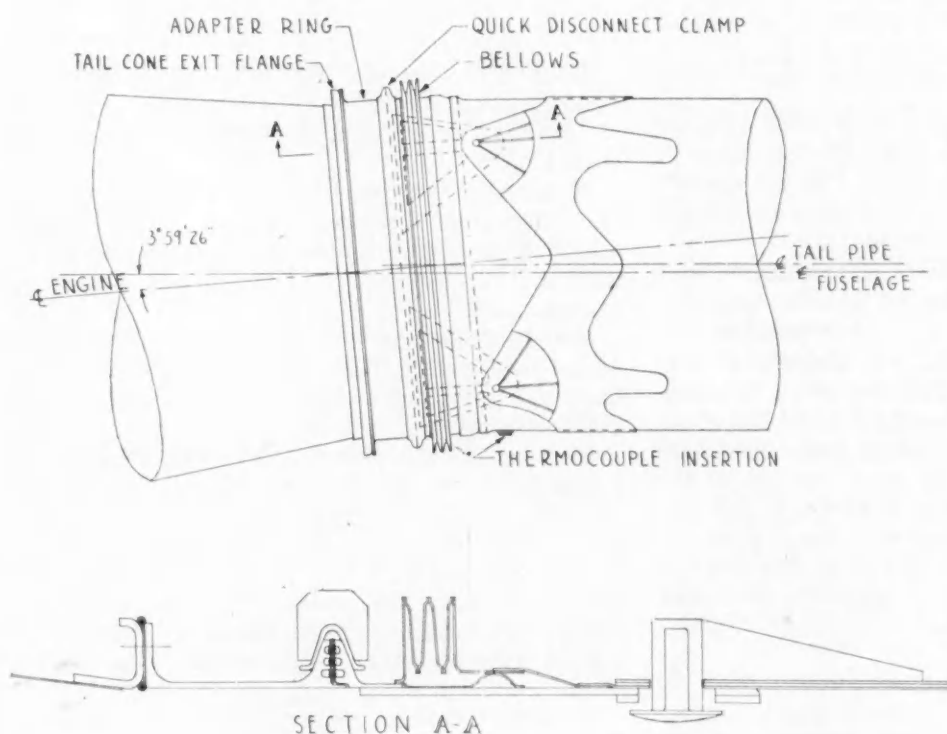


Fig. 1 - Flexible joint with four straps

axial load in the tail pipe. This load was estimated at 5100 lb, based on exhaust-gas pressure of 35 psi and a 21-in.-diameter tail pipe and a 16-in.-diameter jet nozzle. A value of 6000 lb axial load was used for design purposes to allow for possible future increases in engine rating.

3. A quick-detachable joint was required between engine tail cone and exhaust pipe.

In designing to meet the first requirement, it was assumed that the worst bending deflection of the fuselage would occur in the vertical plane. Straps inside the tail pipe were extended rearward from the tail pipe flange. Trunnions mounted on the pipe slide in slots of these straps.

By pivoting in the slots, trunnions prevent bending moment due to tail-pipe deflection from being passed along to the engine tail cone. By sliding in the slots, trunnions accommodate thermal expansion. (Three semicylinders supporting the rear of the pipe slide also along longitudinal channels in the fuselage.)

At first, only two straps were used, but in operation the load transmitted by the straps to the flange was so concentrated that the cone flange simply rolled over and pulled out of the clamp. Requirement 2 certainly was not fulfilled.

There followed a hectic period of static testing, reinforcing, and retesting. The successful strap design is shown in Fig. 1. Four straps (shown dotted) were located 45 deg each side of the vertical centerline. The attachments of the trunnions to the pipe were reinforced with finger patches and gussets. The forward ends of the straps were widened for better distribution of the load into the mounting flange.

The TG-180 tail cone, at the time this installation work was being done, had a flange with 48 bolts for attaching the tail pipe—obviously not a quick-detachable joint. In order to obtain a strong, quick-detachable joint without modifying the engine tail cone, an adaptor was bolted onto the engine cone flange. The adaptor and the tail pipe were built with V-flanges, which were held together by a V-clamp. The joint was sealed by a Cook Electric bellows.

Section A-A of Fig. 1 shows the joint and the clamp with one of its braces. Fig. 2 gives another view of the clamp. This whole design was rugged. When the turnbuckle was properly adjusted, it clamped the flanges and gasket into a strong gas-tight joint.

The flaw in the design was that both toggle and turnbuckle could be reached only through a small access door at the bottom of the fuselage. If the toggle worked too hard or too easily, the mechanic had to rotate the clamp ring 180 deg to adjust the turnbuckle. This might have tempted the mechanic either to leave the clamp so loose that exhaust gases could leak or to force the toggle with the nearest crowbar, which could wreck it.

In order to overcome the flaw, the clamp was redesigned to fasten with a porthole bolt engaging

a slotted ear. Clamps with the new fastening will be used after the present stock has been exhausted.

The clamping arrangement used with a simulated section of the engine tail cone was tested under loads which allowed for the reduction in strength of the materials under elevated temperatures. Loads were applied with the exhaust-pipe joint deflected through an angle equal to the static bend angle plus the angle produced by the calculated fuselage deflection. The engine tail cone stood the

The XP-84 was officially timed at 611 mph at Muroc Army Air Base in August, 1946. This would have been a new world's speed record, had not the British set a record of 616 mph on the same day.

Since that time, the P-84 has averaged 621 mph on a flight from St. Petersburg, Fla. to Eglin Field, Fla. It has been flown from New York to Washington in 17 min.

The P-84 is the only United States jet fighter whose armament has been fully approved by the AAF. In one test, the plane fired 70,000 rounds of ammunition from one set of guns and a complete change of armament was made—all within 30 min.

bending moment and the joint stood the load successfully, proving that Requirements 1 and 2 had been met. And the V-clamp was considered fast enough for Requirement 3.

#### Cooling Provisions

Ventilated shrouding was chosen to protect the fuselage structure aft of the compressor from heat. The shroud weighed less than the insulation blankets then available.

Circulation of air could have been induced by use of either a ram scoop or the ejector effect of the main jet. The ram-scoop idea was rejected because the scoop provides no flow for ground operation. The ejector will induce flow at any time the engine is running.

There was some fear that the ejector would have a detrimental effect on engine thrust. But when thrust-stand tests were made on an engine with the P-84 tail pipe—with and without ejector—the difference in thrust was found to be within the experimental error.

On the strength of this evidence, a shroud was designed for use with an ejector. At the aft end of the compressor, a bulkhead seals the space be-

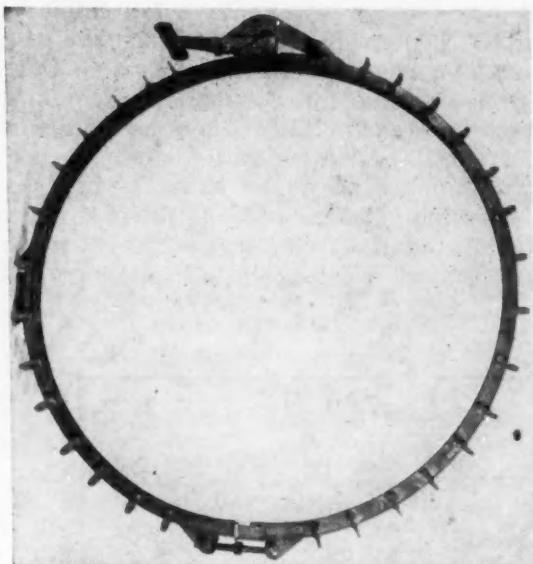


Fig. 2 - V-clamp with toggle and turnbuckle

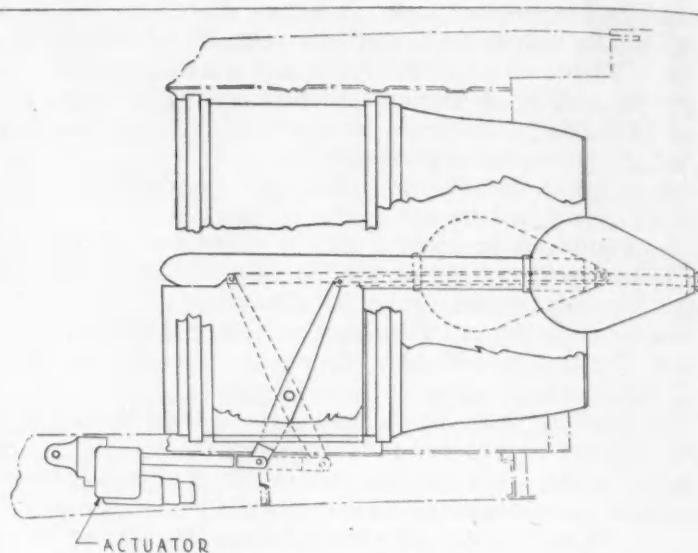


Fig. 3 - Variable-area jet nozzle arrangement

tween the shroud and the skin. All air drawn in through louvers in the fuselage skin just aft of the bulkhead must pass between the shroud and the exhaust piping. The tail pipe ends about 19 in. inside the end of the shroud, giving sufficient mixing length for the ejector action. The shroud merges with the skin at the shroud exit. Between shroud and skin is dead air space.

When the shrouding was flight tested, the thermocouple reading for the rear portion of the shroud went off the scale of the Brown recorder at 572 F.

In spite of this high shroud temperature, temperatures of all parts of the aluminum-alloy fuselage structure were satisfactory. A temperature limit of 250 F had been set arbitrarily for these parts. (This temperature involves only small reduction in strength.) The maximum structure temperatures recorded in flight were about 220 F for the skin and about 279 F for the frames. The frames had ample safety margins at 279 F.

Evidence soon came to light that this cooling capacity was costing a considerable loss of thrust - a finding contrary to the earlier thrust-stand tests. The airplane was tested on a thrust cradle with and without the fuselage rear section. At rated engine speed, thrust was 180 lb greater without the tail, indicating that the ejector dissipates that much thrust. Later tests have cast suspicion on the accuracy of the thrust cradle, but there is no doubt that a considerable loss of thrust is chargeable to the ejector.

#### Fitting the Jet Nozzle

The jet nozzle is welded directly to the end of the tail pipe. The nozzle is formed with double curvature in the longitudinal cross-section so that

the walls at the exit are tangent to a line parallel to the pipe centerline.

Before the nozzle could be formed, it was necessary to calculate the optimum area. The engine manufacturer's thrust-stand tests were made with straight conical nozzles. Because of the vena contracta of a straight cone, it was difficult to calculate the area required for a faired nozzle. Even after some comparative data had been accumulated, faired-nozzle areas could not be calculated with enough accuracy to obtain optimum results with any given individual engine.

The nozzle area calculated by General Electric for their Schenectady-built TG-180 was about 200 sq in., corresponding to a diameter of about 16 in. Test flight and thrust-cradle runs showed that both jet thrust and exhaust-gas temperature are extremely sensitive to small changes in nozzle area. GE had predicted a 3% change in area would change gas temperature by about 100 F and thrust by about 8%. Tests on the installed engine indicate the effect of area changes is even greater.

As other engines of the same type were put into service, it became obvious that nozzle-area requirements differed widely from engine to engine. Experience in building the various nozzles proved that it was impossible to manufacture the sheet-metal parts with sufficient accuracy.

These problems were solved by enlarging the standard pipe and increasing its length 1 in., the final inch being a slight taper. The original 198-sq in. nozzle could be enlarged to as much as 207 sq in. by trimming off the taper. Scribe marks  $\frac{1}{8}$  in. apart were placed on the tapered section to aid in making a square trim and in estimating where to cut for a given reduction in gas temperature after the initial temperature had been deter-

mined from ground tests. This expedient worked successfully.

Then along came the Chevrolet-built TG-180-A5. It required a nominal jet area of 210 sq in.

Another trimmable nozzle was designed with an area range of 206 to 216 sq in. When the Lynn-built model appeared, it required a third size of nozzle. Changes in requirements were due to slight changes in design.

These experiences pointed to the need for making nozzle area adjustable over a considerable range, at least on the ground.

A nozzle whose area could be varied in flight would solve the problem of accommodating the different area requirements of individual engines and it might have two additional advantages:

1. Improvement in cruising fuel consumption might be realized by adjusting the nozzle to optimum area for cruising conditions.

2. Improvement in airplane acceleration and deceleration might result from area control while engine power is being changed. For acceleration, use of a large area at the start would reduce back pressure on the turbine. Thrust would be cut only momentarily to permit the turbine to deliver more power to the compressor per pound airflow.

A bulb-type variable-area nozzle was designed for the XP-84. Its streamlined bulb is mounted on a sliding shaft supported by rollers. The bulb is operated by an electric actuator through a lever pivoted at the vertical support island. Full travel will vary the area from 195 to 240 sq in.

During flight tests, a good deal of burned and semiburned oil collected on the inside of the tail-pipe shroud in the vicinity of the jet nozzle. The inside of the shroud was clean at all points forward of the louvers which had been cut through the shroud to equalize the differential pressure across the shroud. The inside of the fuselage was also clean forward of a joint at the forward end of the ventral fin. There was oil on the outside of the fuselage skin for most of the distance aft of the discharge tube.

First thought was that the oil was leaking from the oil discharge pipe. Through this pipe, the mixture of oil and air sprayed into the bearings is discharged overboard.

Careful examination of the discharge tube disclosed no leaks inside the fuselage or around the joint where the pipe pierces the skin.

The real cause of oil deposition on the shroud was that discharged oil was carried along the outside of the skin in the air stream. At the first leak in the skin—apparently at the ventral fin—the internal suction produced by the ejector drew the oil inside the skin and then through the equalizing louvers to the inside of the shroud.

The whole problem was solved by developing a venturi-type discharge tube, which ejects the oil clear of the skin without projecting beyond the skin.

## AIR TRANSPORT MEETING

continued from page 31

tion by segregating outgoing and incoming passengers and by making it easy for inbound travelers to leave the airport or transfer to outgoing ports. Improved circulation makes the terminal more attractive to friends of travelers and other visitors too, so that more of the public is exposed to the terminal concessions.

After considering how airports should be laid out and terminals built, the engineers turned their attention to problems of efficient use of airport operating personnel and equipment. Success was reported with the cooperative attack being made on the problem at Willow Run, the airport for Detroit, and at Covington, the airport for Cincinnati. At these two points, a terminal company provides almost all the airport services which would be provided normally by individual carriers through their own organizations. Latest figures show that the job is being done with approximately half the personnel which would be required if each carrier provided its own organization.

### Changes Urged in Traffic Control

Air traffic control systems may have to cope with commercial planes flying at speeds of 600 mph within the next 10 years, if the industry continues its progress, an airline official asserted. Present traffic control systems would dissipate all the benefits of such speeds. The speaker advocated four points on which to develop a new system adequate for stepped up speeds:

1. Each pilot must be provided means for indicating to the traffic control agency the flight plan he wishes to follow.

2. The pilot of each aircraft must know his position at all times.

3. The traffic control agency must know continuously the location and, if possible, the identity of all aircraft over which it is exercising control. It must also know the approximate time of arrival of aircraft approaching its area.

4. The traffic control agency must be provided means for indicating continuously to each aircraft the desired position along its route.

One discussor, pitying the poor ground operator of such a system, asked how a mere human could be expected to handle the assignment. The reply was that every possible aid—mechanical and otherwise—would be furnished. It was suggested that standardized phraseology be adapted in order to eliminate the difficulties due to differences in inflection and language.

Asked whether his proposed system was economical, the speaker said that there would be no problem of economics once we can bring airplanes straight into landing strips, without stacking.

BASED ON A PAPER\* BY

**Erold F. Pierce**

Manager

and

**Harvey W. Welsh**

Assistant Project Engineer

Technical Data Division

Wright Aeronautical Corp.

# ENGINES

# for

**O**F all the energy losses in the Otto-cycle engine, the temperature or sensible energy in the exhaust offers the greatest possibility for recovery of additional power and efficiency.

This loss—which comprises 47% of the total energy supplied by the fuel for the Wright Cyclone 18-cyl engine at cruising power and chemically correct mixture strength—is also in a form that can be utilized quite readily.

## Engine Heat Balance

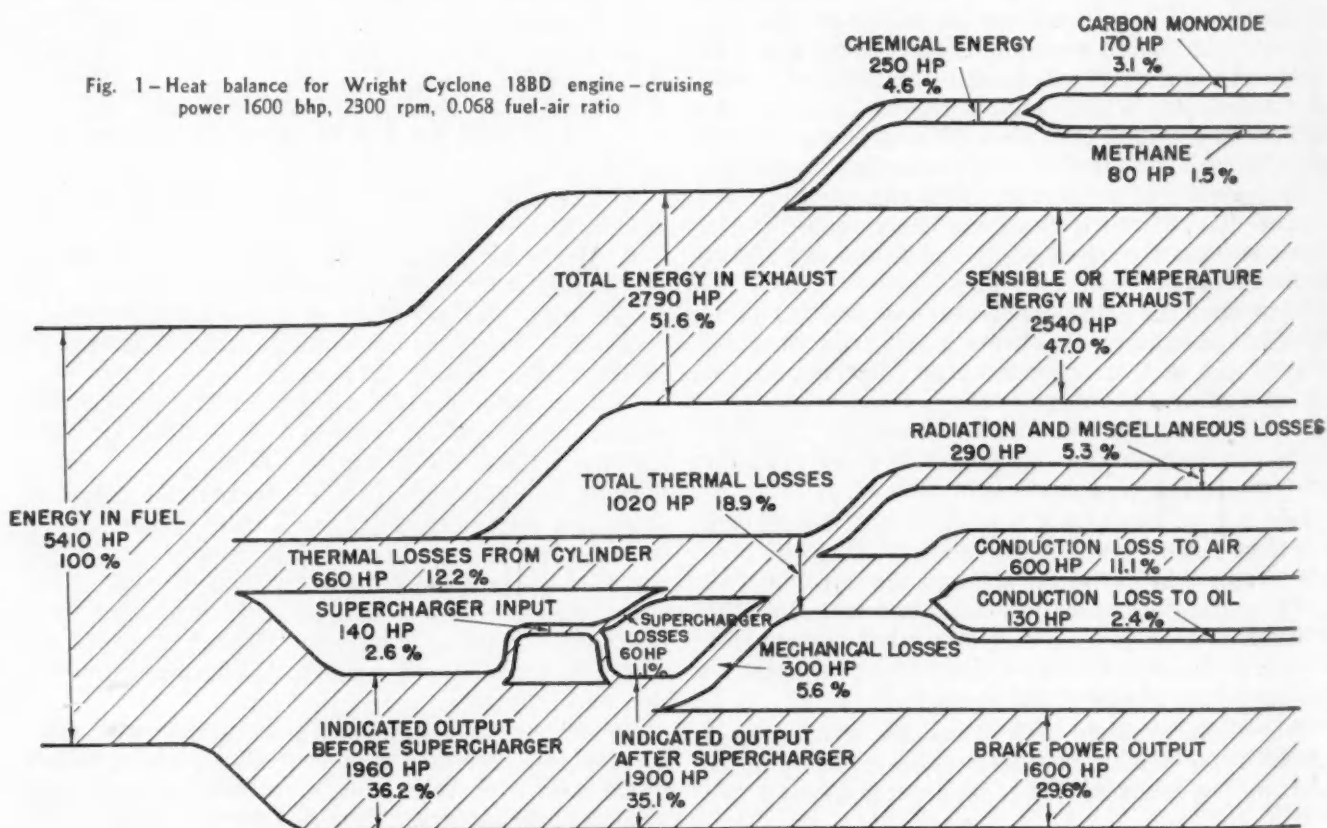
Fig. 1 gives a complete heat balance for this engine. Although this figure represents a particular cruising condition, the ratio of the sensible energy of the exhaust to the brake power output is roughly constant over a wide range of powers. Thus, Fig. 1 indicates that for every horsepower

delivered by the engine, about 1.5 hp is normally rejected as temperature energy in the exhaust.

Less than one-fourth of this energy is available for useful work, however, because of friction losses and low energy availability. In addition, in recovering this energy and converting it to useful work, conduction, radiation, and shock losses will occur.

It is impossible to eliminate such losses, but they can be reduced by insulating the exhaust pipe, by moving the point of utilization close to the valve

\* "Engine Compounding for Power and Efficiency" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1947.



# S COMPOUNDED r More Power

BASED ON PAPER\* BY

**Dimitrius Gerdan**

Chief Engine Engineer

and

**J. M. Wetzler**

ALLISON DIVISION, GMC

and port, and possibly by redesigning the valve and port to reduce shock and expansion losses.

## Exhaust Recovery

Two systems have been devised to recover this energy: in one, the exhaust or blowdown is utilized directly as it comes from the engine; in the other, the blowdown from each cylinder is collected in an exhaust manifold and discharged in a stream that is essentially steady flow. The steady-flow or pressure system gives best results when atmospheric pressure is less than engine exhaust pressure.

Neglecting leakage, the losses in the latter system are relatively constant, regardless of altitude because, as far as the engine knows, it is still blowing down to sea-level pressure, whatever exhaust pressure is maintained. With the pure blowdown system, on the other hand, the loss increases with altitude because, as the exhaust pressure is reduced, the velocity from the nozzle increases, causing greater shock and friction losses. It is to be expected, then, that the net available energy from either system will be the same at some altitude, and above this altitude the pressure system will be better.

This altitude is, of course, dependent on many factors. For instance, the recovery of the pressure system can be increased by raising the exhaust pressure somewhat. In general, however, the performance of the two systems will be equivalent at 25,000-30,000-ft altitude.

## Optimum System

The optimum system of power recovery would be a combination of the blowdown and the pressure systems. In this type of unit, the gas would blow down a pressure of 25-40 in. hg absolute in a blowdown turbine, then it would be collected and ex-

continued on page 61

**A**LTHOUGH an appreciable fuel saving can result from the use of an exhaust turbine compounded reciprocating engine, trouble may be encountered, due to exhaust temperatures being too high for safe operation in the turbine. Tests indicate that either a method of cooling the gases sufficiently to maintain safe operating temperatures must be used or the turbine must be designed to withstand temperatures up to 1950 F.

For example, one series of tests of a conventional, single-stage V-1710 engine having a 6.65 compression ratio and a blower ratio of 9.6 developed 950 hp at 19,000-ft altitude with a cruising consumption of 0.480 lb per bhp-hr, whereas the turbine-compounded engine developed 1040 hp with a specific fuel consumption of 0.395, giving a fuel saving of almost 18%.

Fig. 1 shows the results of a test run at 2700 rpm, full throttle, and 19,000 ft over a range of fuel-air ratios of 0.059-0.084. The comparison is made between a V-1710 engine with and without a turbine.

At minimum specific fuel consumption the turbine compounded engine shows a gain in consumption of about 16%. The gain in power through the use of the exhaust turbine at a fuel-air ratio of 0.064 was 12.5%. At the best power fuel-air mixture condition, the turbine feedback engine gave a specific fuel consumption of 0.454, as compared with 0.520 for the standard engine, the outputs being 1122 and 1018 bhp, respectively. Tests also showed that minimum cruising fuel consumption was maintained at a lower value over a wide range of altitude.

Due to the high exhaust gas temperatures that were obtained at high power and certain other conditions, it was not possible to fly a turbine feedback engine installed in an airplane. Instead, a V-1710-E27 engine was built and a test program conducted with it (Fig. 2). Tests at 30,000-ft altitude and 3200 rpm showed a total power output of 1530 bhp. The calculated turbine horsepower at this condition was 550 and the exhaust temperature was 1600 F. The comparable engine without exhaust turbine developed 1200 hp under the same conditions. At 25,000-ft altitude, 2700 rpm, and a fuel-air ratio of 0.066, the turbine feedback

\* "Allison V-1710 Exhaust Turbine Compounded Reciprocating Aircraft Engine" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1947.

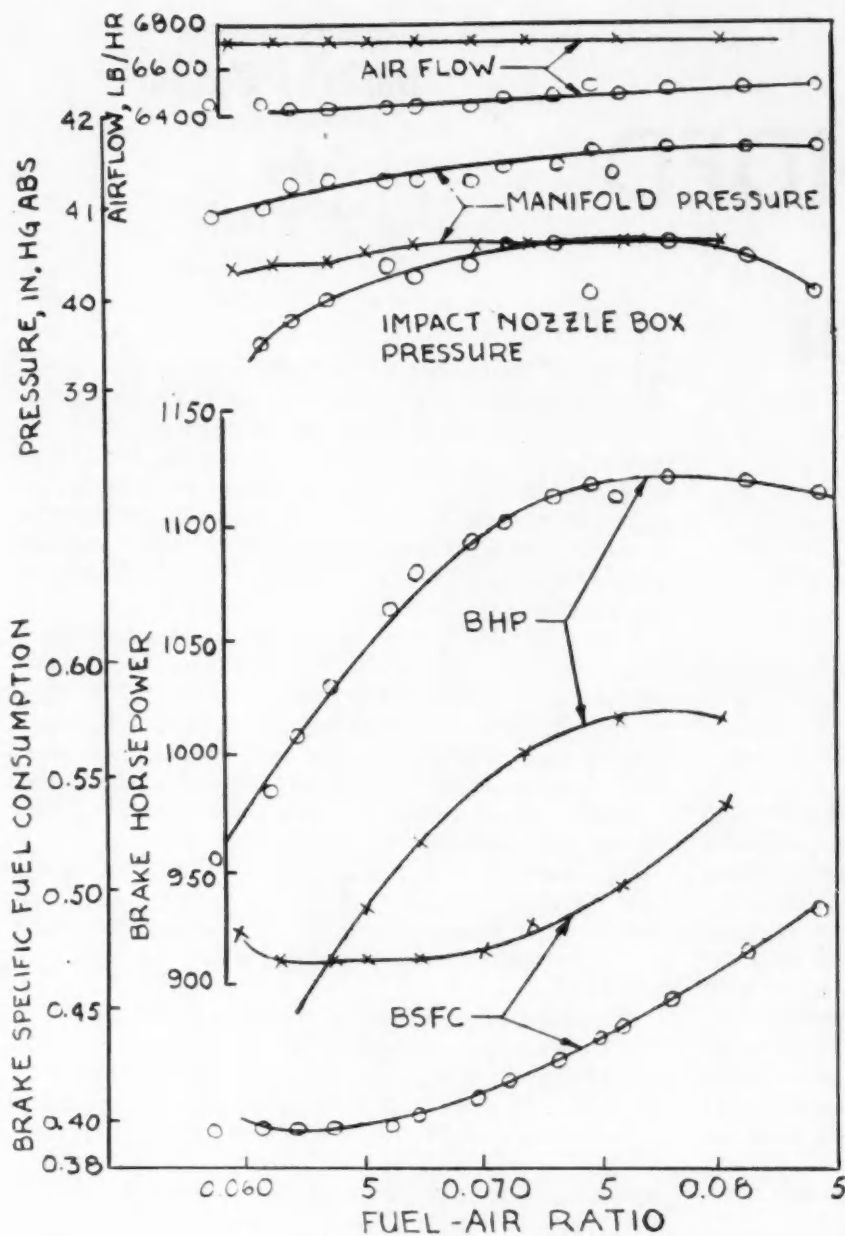
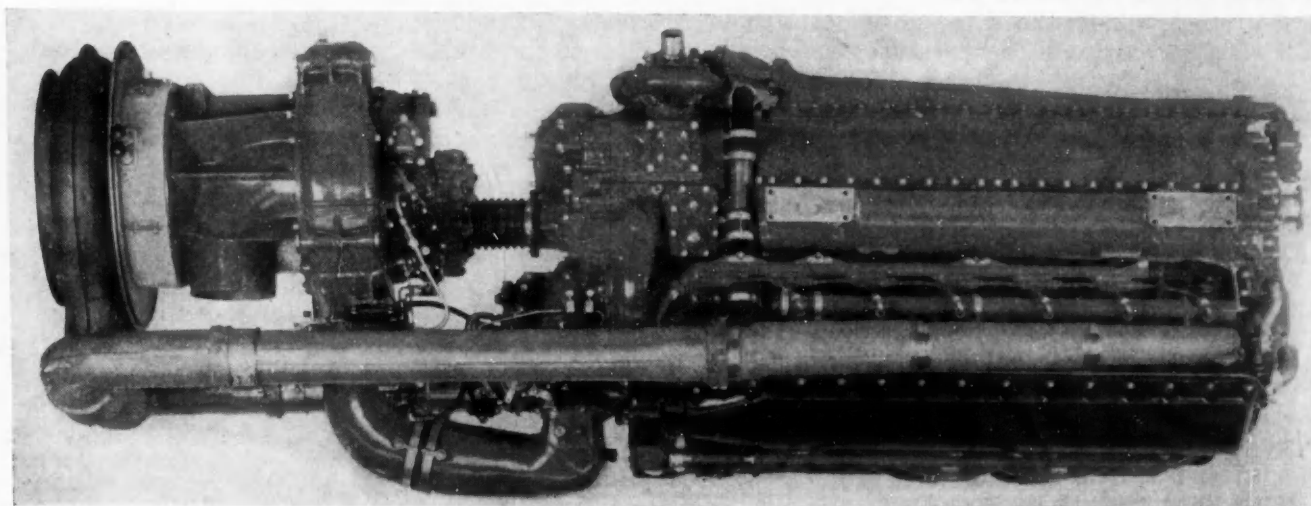


Fig. 1-Turbine power feedback - V-1710-G engine and GE B-31 turbine - 2700 rpm, full throttle, 19,000-ft. altitude - 6.65 compression ratio, 9.6 blower ratio  
X-EX-13 without turbine  
O-EX-19 with turbine

showed a brake specific fuel consumption of 0.450, whereas the conventional 2-stage engine showed a consumption of 0.570. That is, there was a reduction of 21% as a result of exhaust turbine compounding. Under these conditions the engine output increased from 825 to 1120 hp, or there was a gain of 36%.

Despite the revolutionary results obtained in the exploratory tests, it was decided to drop further development of the compounded reciprocating engine, as it was felt that the engineering manpower that would have been required to bring the compound engine to a practical stage would be better devoted to developing the turboprop engine.

Fig. 2-Turbine compounded engine



## Pierce-Welsh Paper Concluded

Continued from page 59

panded to atmospheric pressure through a steady-flow turbine.

The available energy for the three systems in terms of per cent of basic engine output for 30,000-ft altitude is: 46.5% for the pressure system, 36.7% for the blowdown system, and 59.3% for the combination blowdown-pressure system.

### Methods of Recovery

The methods of power recovery are:

1. Jet stacks (Fig. 2A): In this system the exhaust is discharged through individual or siamesed stacks in a rearward direction, exerting a thrust on the airplane, due to the momentum of the gas.

This system is best at low altitudes and high speeds. It has the advantage that some exhaust power can be recovered with it for a relatively low development expenditure. Its performance at low speed and take-off, and the noise level of the exhaust, however, leave much to be desired.

2. Augmented jet stacks (Fig. 2B): If it is intended to use the jet system at low air speeds, it would be desirable to find a means of converting the low-mass-flow high-velocity jet to a high-mass-flow low-velocity jet with a corresponding more favorable velocity ratio, as the ability to utilize energy varies directly as the ratio of air speed to jet velocity. This can be accomplished by an ejector or jet augmentor.

In many respects this method is similar to the familiar steam ejector. A high-velocity primary

jet (the exhaust gas) is discharged into the throat of a constant-area mixing tube, which is roughly five diameters long. In the mixing section, energy is taken from the high-velocity primary jet and transferred to the low-velocity secondary fluid, reducing the velocity of the former and increasing the velocity of the latter. The net result is that the momentum of the mixed gases is greater than the sum of the momenta of the entering primary and secondary fluids.

At low speeds this method is better than the simple jet stacks, but at higher speeds—between 150-250 mph, depending on operating conditions—performance falls off, so that it is inferior to the simple jet.

In addition to acting as an augmentor, the ejector can act as a cooling air pump, providing several inches of water pressure drop while still delivering some net thrust. Such a system appears to have excellent possibilities when operating conditions make cooling exceptionally difficult, since not only is engine cooling improved, but the high drag caused by large flap angles is eliminated.

In general, the merits of this method are that it is simple in design and provides low-speed power recovery and cooling at reasonable cost in addition to producing some muffling effect.

3. Blowdown turbine (Fig. 2C): This system converts the kinetic energy into useful power in a turbine. Turbine output can be transferred to the crankshaft through gears, or it can be used to drive accessories, should the auxiliary power requirements be large. This type of blowdown system is more complicated and may cost more to develop than either of the previous types, but it has the advantage not only of greater recovery in the low- and moderate-speed regimes, but of maintaining a favorable power-weight ratio with improved fuel consumption.

Exhaust blowdown is a process of violent fluctua-

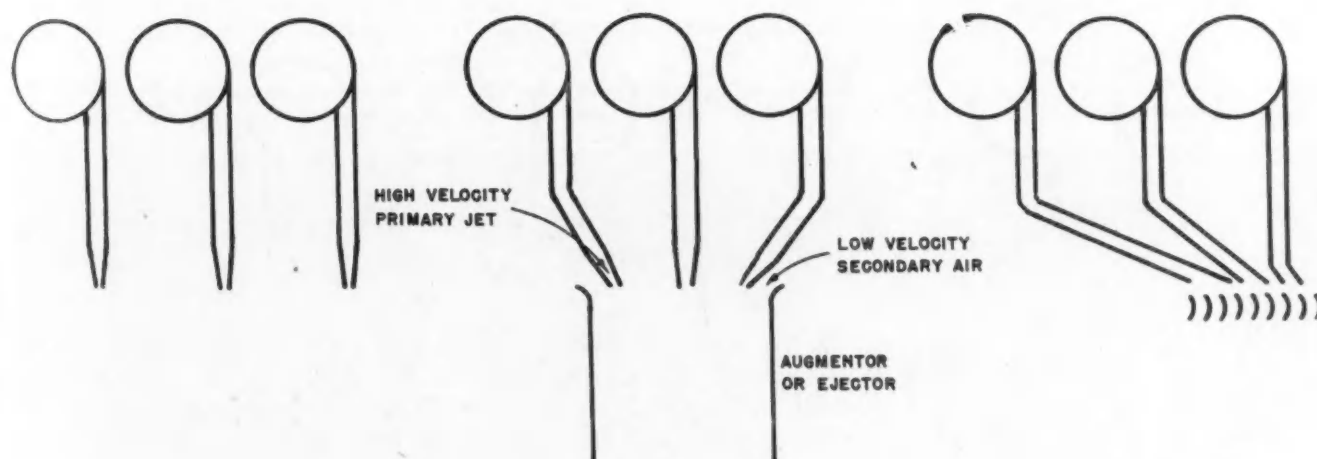


Fig. 2—Blowdown power recovery methods: A (left): jet stack; B (middle): augmented jet; C (right): blowdown turbine

tion, and its application to turbine power recovery requires more design compromise than is necessary with a steady-state turbine application. Obviously, the turbine blade design can only attempt to compromise the wide variation.

The blowdown turbine is by far the best system for moderate air speeds and low and medium altitudes in long-range operation. The high power available for take-off is extremely important, especially when compared to jet stacks. The increase in power, and the reduction in fuel consumption, combine to effect significant improvements in airplane performance.

Power recovery engines of the blowdown type can be built with the same cowl line and with little increase in engine length, and deliver 15% or more take-off power.

4. Pressure or steady-flow system (Fig. 3): This method of converting the energy to a useful form is quite similar to that just considered, since power can be recovered in a form of jet thrust by means of a turbine. The jet thrust of the pressure system is mainly of academic interest, for in general the pressure system requires some form of turbine for efficient recovery.

The pressure turbine system differs from the usual turbosupercharger system in that there is no waste gate, so that all the exhaust gas, except for leakage, passes through the turbine, and the power output is not necessarily used to drive a compressor. For high-altitude operation an auxiliary compressor is needed, but the available power is in excess of the supercharger power required. The excess can be recovered and returned to the engine crankshaft or to the accessories. The necessary division of power can be accomplished by using two or more turbines in parallel, one driving the compressor, the others feeding power back into the engine.

One advantage of the pressure turbine system over the blowdown system is that the steady flow

of the exhaust gas results in high turbine efficiencies. If the blowdown turbine can attain 60%, the pressure turbine should have little difficulty in reaching 65%. This advantage is partially overshadowed by the leakage problem, which can be rather severe, due to the large pressure difference between the exhaust manifold and the atmosphere.

If a blowdown turbine and a pressure turbine system are placed in series to give a double-compound engine, a system is formed that has a definite advantage for high-altitude work in that satisfactory operation can be attained with one, or at most two, turbine-to-engine gear ratios. This is due to the fact that the discharge pressure on the blowdown turbine (which returns power to the crankshaft) is always operating at a turbine exhaust pressure that is roughly independent of altitude, hence the blowdown velocity is almost constant.

A convenient division of power is to use the pressure turbine to drive an auxiliary supercharger, while the blowdown system returns power to the engine crankshaft. A waste gate must be included between the turbines to control the pressure drop across the steady-flow unit and the power output, which represents a power loss unless the available jet thrust is utilized. The loss through the waste gate is fairly small, however, since the blowdown turbine has already removed energy from the gas and reduced its temperature, resulting in a more nearly closed waste-gate position than in the usual turbosupercharger installation.

At very high altitudes, the pressure turbine system and the double-compounded pressure-blowdown system are practically without competition.

5. Binary cycle: In this system the heat of the exhaust is transferred to a second medium as, for instance, a steam turbine system. Although it gives good recovery, the equipment required is quite complicated and heavy, making its application to aircraft somewhat doubtful.

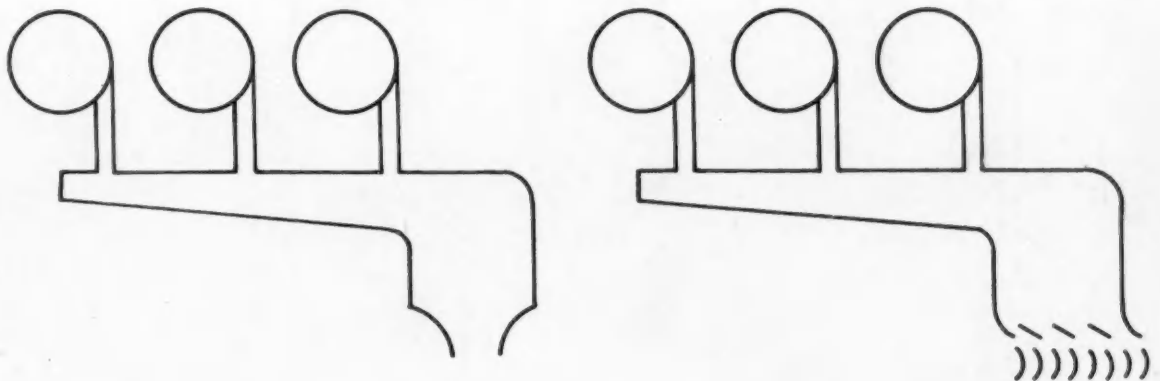


Fig. 3 - Pressure power recovery methods: A (left): pressure jet, B (right): pressure turbine

# Turboprop Problems Solved in Minutes

Based on paper

By G. A. PHILBRICK

G. A. Philbrick Researches, Inc.

W. T. STARK

and W. C. SCHAFER

Wright Aeronautical Corp.

THE Electronic Analog cuts solution of turboprop control system problems from days to minutes.

This research tool computes and shows instantly the effect of changing any one of the five dynamically and statically interrelated variables in turboprop controls. They are speed, torque, temperature, fuel flow, and propeller blade angle. See Fig. 1. The computer finds the best combination of variables for the design.

## Complex Calculations

Doing the job analytically involves seventh order differential equations. Empirical methods call for costly test equipment and experimentation. Both consume days of calculation and test. But neither establishes the optimum design.

The Analog shows behavior of the variables during and after introduction of transient disturbances. It displays problem solutions on an oscilloscope. They appear as a stationary plot of the transient variation against a synchronous time base. An automatic camera photographs the plots.

Correlation between Analog results and full-scale engine tests has been established. Control systems predicated on Analog information have performed as anticipated on turboprop engines.

Analog investigations were made of the independent control of speed and temperature in the initial stages of development. These checks were made by establishing various operating condi-

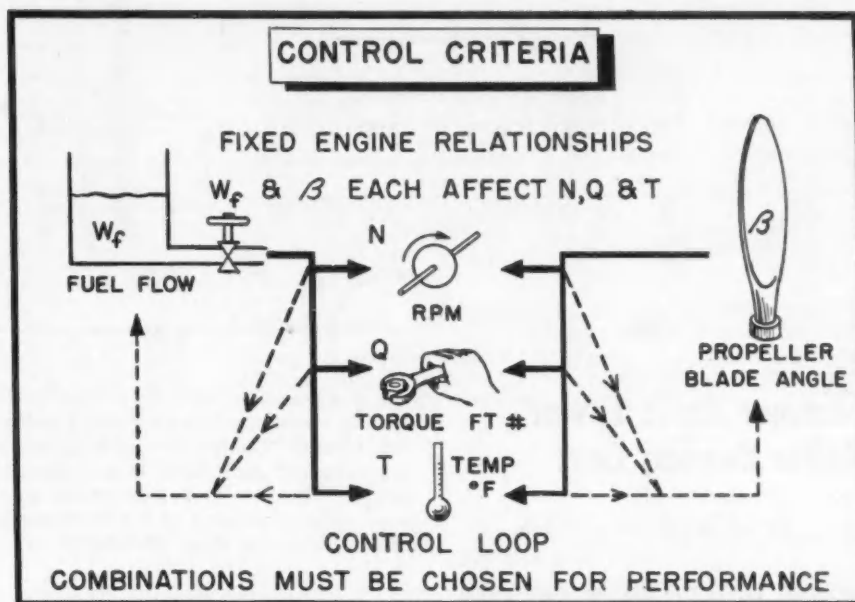


Fig. 1—Related influences of the five variables in turboprop engine control. The Electronic Analog computes the best combination for a given performance in a small fraction of the time it takes by calculation or test

tions and then introducing a step disturbance to each variable.

Fig. 2 shows a typical Analog result. It reveals the effect on speed and temperature of a 10% instantaneous disturbance to propeller blade angle. Selecting the control system in this case involves evaluation of 25 design characteristics, under influence of four types of disturbance and at least eight operating conditions.

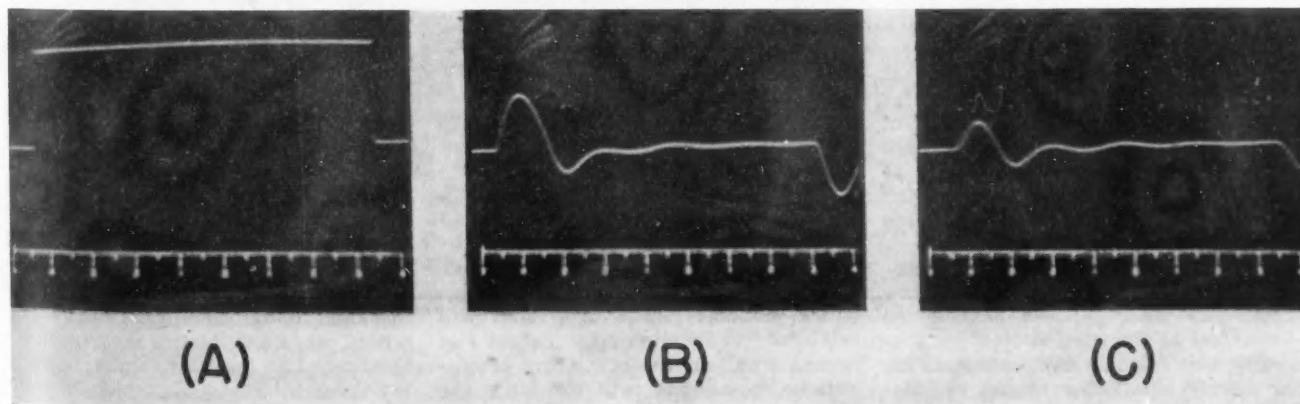
The Analog does the job in a day. By analytical or empirical methods it would take months. Over one million possible combinations must be investigated.

The Analog gives continuous simu-

lation. The operator can immediately scan and record in short order each characteristic evaluation.

This instrument also evaluates effect on performance of production tolerances and service deterioration of both engine and controls. It will evaluate complex dynamic phenomena such as lag. Principle of the Analog computer and how it works will be described in detail in the paper to be printed in full in SAE Quarterly Transactions. (Paper "Electronic Analog Studies for Turbo-Prop Control Systems," was presented at SAE National Aeronautic Meeting (Fall), Los Angeles, Oct. 3, 1947.)

Fig. 2—The Analog shows what happens to speed and temperature in a typical turboprop engine with a 10% instantaneous disturbance of propeller blade angle. (A) shows the 10% disturbance to blade angle, (B) speed error, and (C) effect on temperature



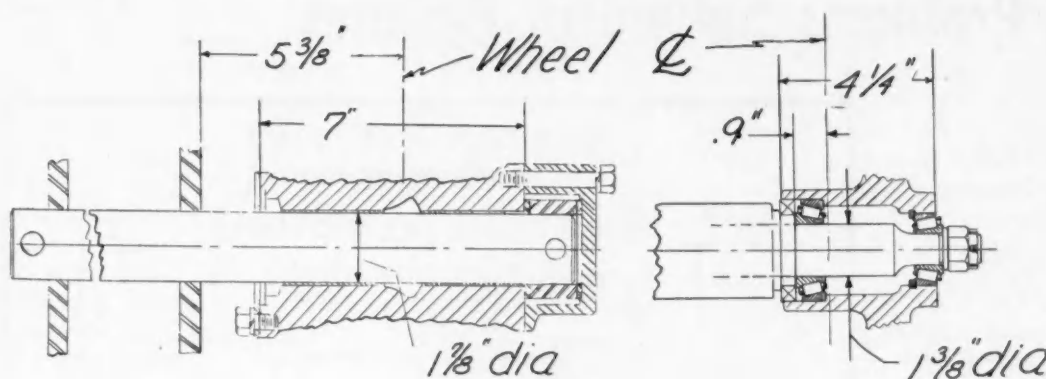


Fig. 1—Stationary axles for typical implement service such as combines, corn pickers, and manure spreaders can be equipped with roller bearings in place of the friction type at no increase in cost—if the axle is redesigned. The 1 3/8-in. diameter axle at right with tapered roller bearing was found to be as strong, and no more costly, than the 1 3/8-in. diameter axle design at left with friction bearing

## Slimmer Axles Lower Roller Bearing Cost

Based on paper

By **GEORGE W. CURTIS**

Timken Roller Bearing Co.

**M**INIMIZING the diameter of tractor and implement stationary axles makes roller bearings as cheap as sliding bearings.

This proved to be the case in tests for a 2100-lb per wheel condition. Results showed a 1 3/8-in. stationary single-wheel axle with friction bearing could be replaced—at no greater cost—by a 1 3/8-in. axle with tapered roller bearing. Stress under static bending test was 18,000 psi for the larger axle compared to 7400 psi for the smaller one. Fig. 1 shows both designs.

Difference between cost of tapered and friction bearings, according to estimates of some manufacturers, was offset by the following savings with the modified design:

1. Axle weight reduced 70%;
2. Weight of other parts reduced 70%;
3. Machine time reduced 30%.

This tapered roller bearing and lighter axle have given satisfactory field service over the past six or seven years. They are proving their merits in nearly 100,000 machines.

### Machining Flaws

There have been a few failures at the axle diameter adjacent to the outer bearing under comparatively light loads. But the design was not at fault. Sharp tool marks left unsmoothed at the radius on the inner end of the 13/16-in. diameter of the axle were responsible.

This same kind of design approach—reducing weight and cost of parts—makes the roller tapered bearing as economical as the friction type for stationary and rotating dual-wheel axles. For nearly equal first costs, the de-

signer gives the farmer a longer-life bearing requiring less frequent lubrication. (Paper "Comparison of Stationary and Rotating Axle Idler Wheel Mountings for Tractor and Implement Service," was presented at SAE National Tractor Meeting, Sept. 18, 1947.)

## Heat Needed in Wing Can Be Calculated

Digest of paper

By **CARR B. NEEL**

National Advisory Committee for Aeronautics

(This paper will be published in full in SAE Quarterly Transactions)

**T**HE state of the art of designing heated wings for aircraft has reached a point where design on a fundamental, wet-air basis can be undertaken with reasonable certainty of success.

### Three-Point Approach

The recommended procedure for determining the heat required for a wing thermal ice-prevention system takes into consideration three factors:

1. Meteorological and flight conditions
2. Area of water impingement, and rate and distribution of impingement over that area
3. Rate of evaporation from wing surface

The thermal system should be analyzed for five particular combinations of water content, drop size, and air temperature—combinations found by NACA to present maximum probable icing conditions. One combination, which embodies large drop size, will establish the minimum extent of heated area. Of the other four combinations, some one will establish the

critical condition for heating requirements.

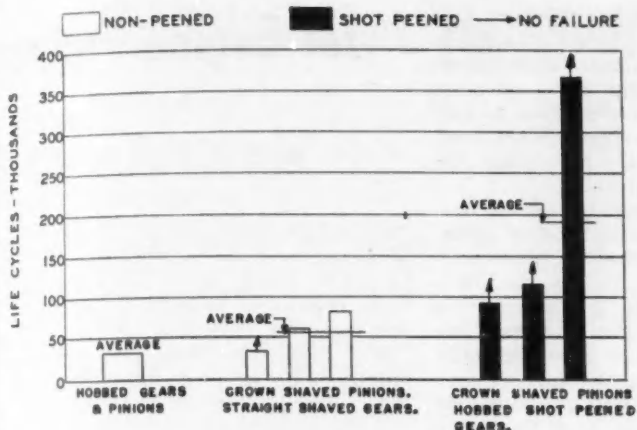
The ice-prevention system should be designed to take care of all altitudes from sea level to 20,000 ft. Low altitude will probably be critical for a thermal system designed with a fixed heat flow, such as an electrical system. High altitude will probably be critical for air-heated systems.

The best air speed for design is usually a low cruise condition. Reason for this is that pilots usually fly slowly through the turbulent conditions often accompanying icing. This is good practice because, at low speeds, a low rate of heating will be sufficient for the low rate of water impingement.

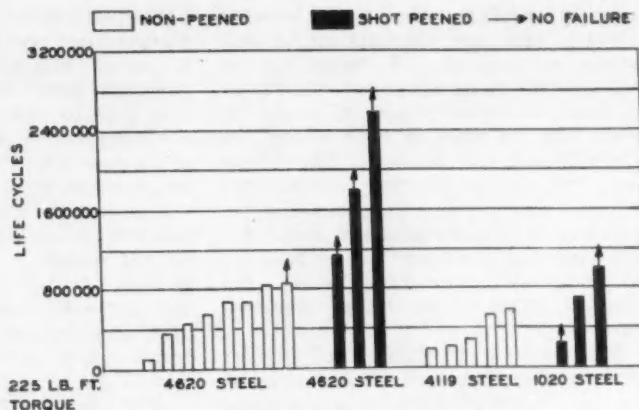
### Water on the Wing

For calculating area and rate of water impingement on the airfoil, the design procedure calls for substituting the leading-edge cylinder for the airfoil and applying certain design curves already available. Distribution of impingement over the airfoil leading-edge region can be closely approximated by assuming a triangular distribution. The highest rate of impingement is at the stagnation point, the rate tapering off to zero at the end of the area of impingement.

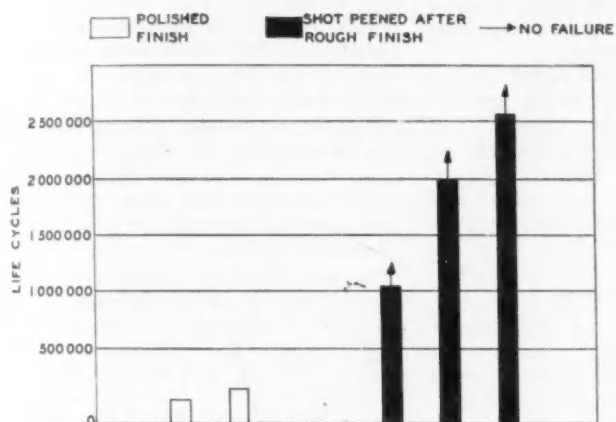
If a wing is to be heated only in the leading-edge region, all the water intercepted must be evaporated there. Otherwise, the runback water might form ice aft of the heated region. Calculation of the rate of evaporation of intercepted water will determine the rate of heat flow needed and the extent of heated area needed. Two simple equations exist for calculating the required heat flow—one for the area of impingement and the other for the area aft of the impingement area. (Paper "Calculation of Heat Required for Wing Thermal Ice Prevention in Specified Icing Conditions," was presented at SAE National Aeronautic Meeting, Los Angeles, Calif., Oct. 3, 1947.)



**Tractor Gears** Shotpeening final drive ring gears on Allis Chalmers tractors extends their life 400 to 600%. The rough peened surface betters lubrication because the small indentations act as oil reservoirs.

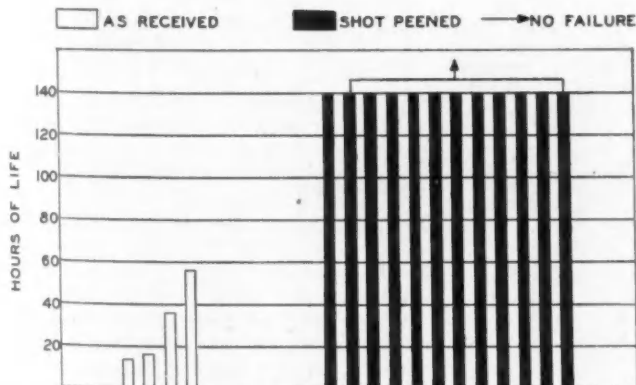


**Transmission Gears** Here's another way shotpeening saves the manufacturer money. These are data from tests on carburized low-speed sliding gears of a Fuller transmission. Life of shotpeened gears of SAE 1020 steel is at least as good as the unpeened gears made of the alloy steel - SAE 4620.



COMPARATIVE FATIGUE DURABILITY OF POLISHED AND ROUGH FINISHED, SHOT PEENED FORK TYPE CONNECTING RODS.

**Connecting Rods** Peened connecting rods in Packard-built Rolls Royce engines revealed another advantage of shotpeening. It saves many man and machine hours by eliminating grinding and polishing. The rods shotpeened after rough finish outlasted the polished ones.



**Rocker Arms** Life of valve rocker arms in a General Motors truck engine ranged from 17 to 57 hr without peening. Of twelve shotpeened parts tested, the first failed after 140 hr.

## Test Cases Prove Shotpeening Merit

Based on paper

By FRED. K. LANDECKER

Metal Improvement Co.  
(This paper will be printed in full in SAE Quarterly Transactions)

**EXPERIENCE** shows shotpeening lengthens life of vehicle parts by setting up resistance to fatigue failures.

It imparts a high residual compressive stress to the surface. This beneficial treatment has been successfully used on parts subjected to fatigue, shock, and impact such as springs, gears, axle shafts, crankshafts, and connecting rods.

The charts shown here demonstrate the value of shotpeening, determined by actual test, for just a few such parts. (Paper "Shotpeening," was presented at SAE National West Coast Transportation & Maintenance Meeting, Los Angeles, Aug. 21, 1947.)

## Why Carburetors Ice

Based on paper

By E. E. DEAN

Carter Carburetor Corp.  
(Retired)

**THE** carburetor ices because it is a very efficient refrigerator. At idling it can freeze sufficiently to choke off air supply and stall the engine.

Freezing takes place at the throttle plate. At partly-closed throttle, ice

quickly bridges the gap between throttle and bore. It cuts off air and stops the engine. Ice forms at the throttle for two reasons.

First, at from idling to about 30 mph, air pressure is high above the throttle and low below it. High-pressure air forces its way around the throttle opening at high speed and expands into the low-pressure zone. Air releases heat during the expansion, lowering temperatures below the throttle. This is the initial temperature drop.

Evaporation of idling fuel further drops the temperature. Heat to vaporize this fuel must come from air below the throttle. Idle fuel discharges at

high speeds into this low-pressure, low-temperature region. It breaks up into a fog of fine particles. These small particles immediately form globules that present the greatest area to surrounding air. They absorb more heat, are again vaporized, and reduce the temperature still further.

This refrigerating action leaves final mixture temperature well below freezing. It makes the throttle plate cold. Moisture in the air strikes the plate and turns to water. It flows to the edge and freezes. This increases effective plate diameter and eventually chokes the air intake opening. (Paper "Carburetor Icing," was presented at SAE St Louis Section, June 10, 1947.)

## Jet Engine Progress

Based on paper

By E. M. PHILLIPS

General Electric Co.

**G**REATER resistance to the high temperature-stress combination in rotating jet engine parts will come from both improved production techniques and improved materials.

For example, hot-cold working lengthens life of large disc-wheel forgings. Proper contour forging extends the treatment to the hard-to-get-to cen-

## Sealed Crawler Wheel Makes Lube Job Last

Based on paper

By J. T. LIGGETT

Allis-Chalmers Mfg. Co.

**C**RAWLER tractor truck wheel and seal development has made the farmer's daily greasing chore a semi-annual one.

Today Allis-Chalmers tractor truck wheels need lubrication once every 1000 hr of operation—about six months. Fig. 1 shows the wheel design that ended daily grease needs of its predecessors.

Its reversed taper roller bearings prevent radial and endwise looseness.

They, together with shims under a retainer, accurately and permanently position the hub. The retainers are pulled up tight against shims; portion of the rim bent up into the spanner notch securely locks them.

The revolving member—seal plate—contains a rubber ring in its grooved outer diameter. This assembly is forced into the bore of the bearing adjusting retainer. The tight-fitting rubber in the bore serves as gasket and positive drive for the seal plate.

### Seal Ring Described

A stationary seal ring fits loosely on the shaft. A synthetic rubber tube holds it against the plate. Both ends of this tube or boot are cemented into

tapered annular grooves for torsional anchorage. Neoprene makes the best lubricant- and temperature-resistant boot material.

In later designs an added spring assembly supplements boot resiliency. It maintains continuous contact pressure on the sealing surfaces.

Specially-developed equipment injects fluid lubricant through the axial bore, just inside the outer bearing. Using light grease with good cold-stiffening properties extends between-lubrication period.

Continued design efforts give promise of a lubricated-for-life crawler tractor truck wheel. (Paper "Truck Wheel Seal History," was presented at SAE Central Illinois Section, Peoria, June 9, 1947.)

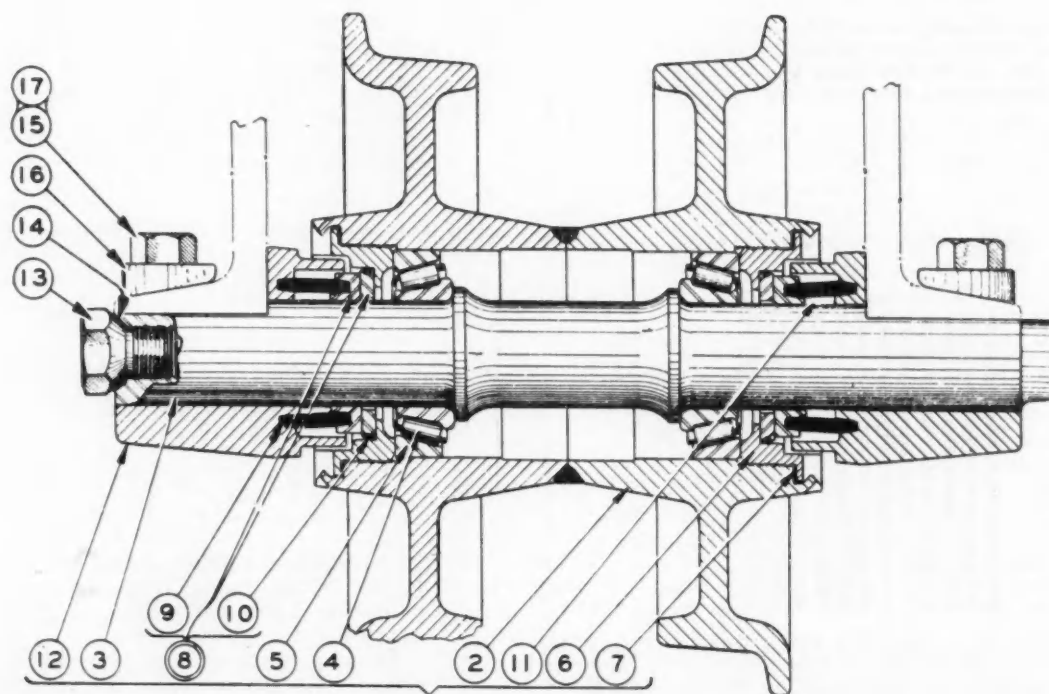


Fig. 1—This crawler tractor truck wheel with its positive type seal saves operating expense and time. It retains the lubricant, ends daily greasing

## Keyed To Fabrication, Metallurgy

ter section.

Proper inspection methods also insure satisfactory forgings in production lots. The Zygo black-light process finds surface flaws which produce adverse effects. Supersonic and X-ray inspection detect internal imperfections likely to cause service failures by crack progression.

Flash welding high-temperature alloy wheel discs to low-temperature steel shafts minimizes the softened area. Annealing at below-tempering temperatures strain-relieves the welded area.

But production men find solid wheel discs open to improvement. They consume more strategic material than necessary; their production calls for large forge hammers and expensive production dies. The composite wheel eliminates such solid disc-wheel costs without losing their advantages.

Here a ferritic low-temperature steel hub and disc unit are welded to a heat-resistant alloy ring—such as Timkin alloy. This eliminates one welding operation; the hub forging now includes the shaft extension.

The materials that go into the engine are as vital to its performance as manufacturing methods. Materials chosen must limit distortion. Otherwise rubbing followed by overheating and vibration invites destruction. High-temperature strength and creep resistance are also requisite properties. They combat distortion and cracking when design confines movement due to local temperature variations.

Upon proper balance between rupture strength, creep resistance, and ductility at processing temperatures depends success of operations such as welding. Many high-temperature materials have poor conduction properties; high temperature-shock resistance counters this shortcoming.

Materials rotating at high speeds must be structurally stable with temperature change. Some alloys lose structural strength at high temperatures; they become useless.

Tests and research have already disclosed characteristics such as rupture resistance of current bucket and wheel alloys. See Figs. 1 and 2. But further tests must disclose whether today's materials possess all these required properties. Ways must be found to determine and ensure conformity of material supplied with specimen performance and properties. And greater turbine reliability and life demand continued search for new alloys. (Paper "The Metallurgical Aspects of Turbine Wheels and Nozzles," was presented at SAE National Aeronautic Meeting (Fall), Los Angeles, Oct. 3, 1947.)

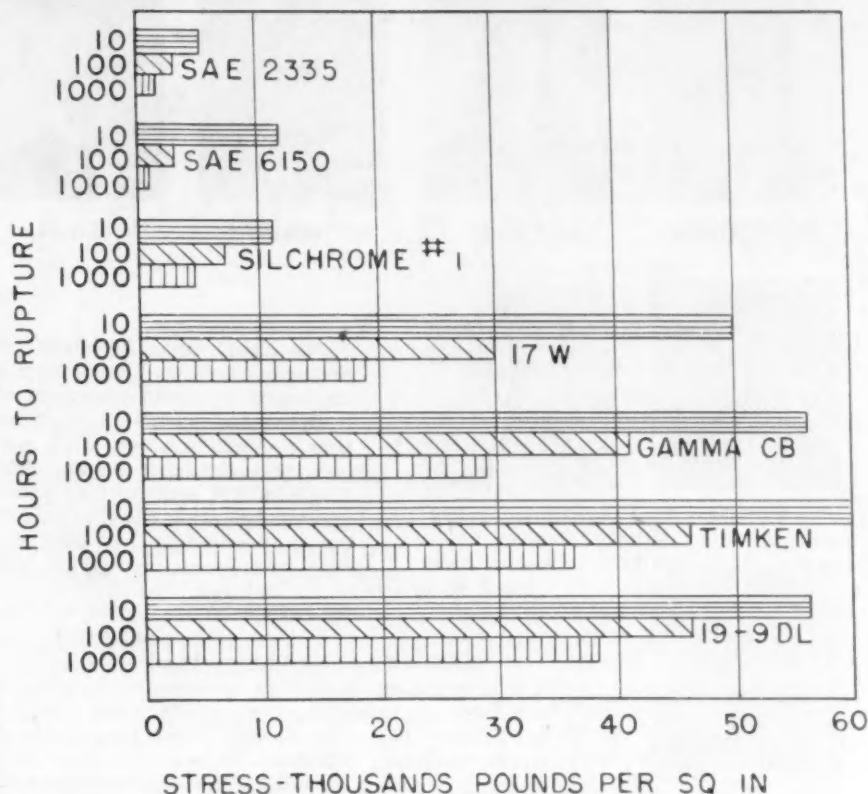


Fig. 1—This chart shows rupture resistance of wheel alloys at 1200F

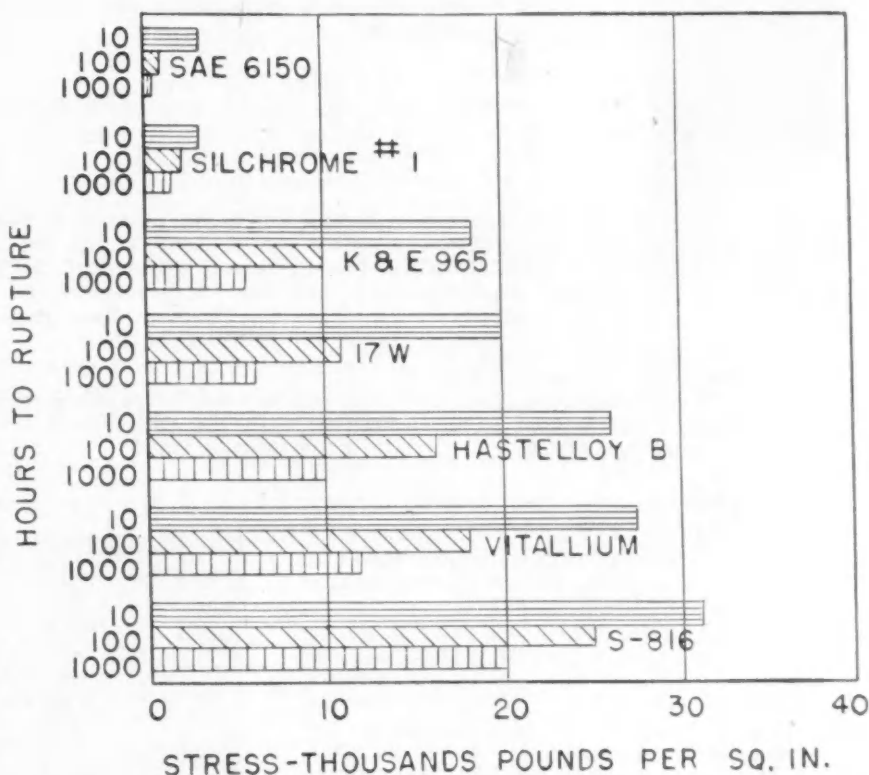


Fig. 2—Turbine bucket alloys currently used will work at the stresses shown at 1500F for the indicated periods before failure by rupture

## SAE MEMBERS IN ETHYL REORGANIZATION



BARTHOLOMEW



MACAULEY



HAWLEY



SCALES



TAYLOR



WINTRINGHAM



CALINGAERT



KERLEY

Now chief engineer for the Stockton Works of the J. I. Case Co. in Stockton, Calif., **MATTHEW E. HAMILTON** had been a project engineer connected with Harry Ferguson, Inc., Detroit.

**WILLIAM E. HANN** recently became vice-president and general manager of Vesubio Mining Corp., Ltd. in Calexico, Calif. Prior to this, he was a patent attorney in Detroit.

The Ethyl Corp. Research Laboratories in Detroit have been reorganized to group personnel and equipment for maximum peacetime productive effort. SAE members involved are: **EARL BARTHOLOMEW** continues as general manager of the Ethyl Laboratories, a position he has held since that office was created in 1945.

**JOHN B. MACAULEY** has been appointed director of research and **CHARLES D. HAWLEY** has been made manager of administration and financial control. **RICHARD K. SCALES** will continue as director of technical service, a position he held before the reorganization plan became effective. **JOHN B. TAYLOR, JR.**, has become executive engineer. Three associate directors of research have been appointed. They are **JOHN S. WINTRINGHAM**, research on automotive products, **DR. GEORGE CALINGAERT**, research on manufacturing and chemical products and **ROBERT V. KERLEY**, research on aviation products. **COLEMAN L. DAVIDSON** has been made manager of automotive research operations.

Now a consulting automotive engineer for the Bedford Garage Service in San Francisco, **GERALD C. DUNBAR** had been supervisor of Rural Lines for the Northern Pennsylvania Power Co. in Towanda, Pa.

**EDGAR L. CRALLE** is now a junior engineer with the Cities Service Oil Co. in Bartlesville, Okla.

**JOHN M. CAMPBELL** was recently appointed head of the Organic Chemistry Department of the Research Laboratories Division at General Motors Corp. in Detroit, according to an announcement by **C. L. McCUEN**, GM vice-president and general manager of the division. **ROBERT SCHILLING** has recently assumed the responsibilities of head of Mechanical Engineering #1 Department. **JOHN ALMEN**, present head of this department, has asked to be relieved of his supervisory duties because of ill health.



CAMPBELL



SCHILLING



ALMEN

# About

Having served as field engineer for Rogers Pattern & Foundry Co. in Los Angeles, **FREDERICK W. DADSON** is now a sales representative for Servel, Inc., in Evansville, Ind.

**P. A. DE PADOVA** is now a project engineer with the M. W. Kellogg Co. in Jersey City, N. J. Prior to this he was research engineer with the Eclipse Pioneer Division of the Bendix Aviation Corp. in Teterboro, N. J.

**ELLIS W. TEMPLIN**, Los Angeles, was one of the contest field judges at the National Truck Roadshow held during the recent convention of the American Trucking Associations, Inc., in Los Angeles. Among SAE members who attended were: **JULIUS GAUSSOIN**, Silver Eagle Co., Portland, Ore.; **J. L. S. SNEAD, JR.**, Consolidated Freightways, Inc., Portland, and **HOY STEVENS**, American Trucking Associations, Inc., Washington, D. C.

Appointments within the Engineering Department of the Weatherhead Co. in Cleveland have recently been announced. They include **B. R. TERE**, who is chairman of SAE Committee A-6, Aircraft Hydraulic and Pneumatic Equipment, promoted from laboratory director to engineering manager; **GEORGE TANKER**, who has been made project engineer for L.P. Gas Equipment and **CHARLES CRAWLEY**, who has been made chief project engineer.

**CHARLES L. McCUEN**, vice-president and director of research of Gen-

# Members

**MAURICE PLATT**, passenger vehicle engineer, and **HAROLD DREW**, assistant chief engineer and a director of Vauxhall Motors, Ltd., have sailed after a month's tour of General Motors and other automotive plants in this country.

**ROBERT L. DICK** formerly chief engineer with the Murphy Diesel Co. in Milwaukee, has been appointed chief experimental engineer with the LeRoi Co. He is a former chairman of the SAE Milwaukee Section.

**C. E. WILSON**, president of General Motors Corp., turned over an industrial exhibit to the Chicago Museum of Science and Industry on Nov. 14. Occupying more than 10,000 sq ft, the exhibit, depicting the development of transportation, has 78 units and runs 1100 lineal ft.

The recently-published book, "Introduction to Aerodynamics of a Compressible Fluid," by **ALLEN E. PUCKETT** and **HANS W. LIEPMAN**, is one of the most complete treatments of the subject in English. The authors develop this report of present-day theory in studies of one, two and three dimensional motions of compressible fluids. They have assembled most classical elementary problems, emphasizing derivation and meaning of fundamental aerodynamic relationships.

eral Motors Corp., has been elected a director of the Ethyl Corp. in New York City.

**EDWARD WARNER**, president of the Council of the International Civil Aviation Organization in Montreal, Canada, an agency of the United Nations, was the principal speaker at the annual luncheon of the American Standards Association in New York City on Oct. 23. He spoke primarily on standard practices in international flying and how these can aid world trade.

**E. D. WILKIN** recently assumed the duties of chief engineer at the Johnston Lawn Mower Corp. in Ottumwa, Iowa. He was previously connected with Salisbury Motors, Inc., at Pomona, Calif.

**WALLACE LINVILLE**, who is president of the Acelin Corp. in Los Angeles, was guest speaker on the "Leaders of Tomorrow" radio program on station KMPC on Oct. 21. He answered questions on engineering problems. Linville is a past-chairman of the SAE Southern California Section.

The Trustees of the James F. Lincoln Arc Welding Foundation recently announced the awards in its \$200,000 Design-For-Progress Program. The third main award of \$8,200 went to **G. J. STORATZ**, an SAE member, who is chief engineer of the Road Machinery Division of the Heil Co. in Milwaukee. **HERBERT C. WENDT**, also an SAE member, won the first Automotive Classification award of \$3,200. He is a body engineer working in design and production engineering for General Motors Corp., Overseas Operations, Detroit.

Now employed with the Power Generators, Ltd. in Trenton, N. J., in the capacity of stress analysis engineer, **LEON FORREST** had previously been connected with the Winner Mfg. Co., Inc. in West Trenton.

**BRUNO E. STECHBART, JR.**, recently became design engineer for the

Belmont Radio Corp. in Chicago. Prior to this he held a similar position with W. F. Hebard & Co., same city.

No longer connected with the American Locomotive Co. in Schenectady, N. Y., **JOHN SEAGREN** has now become chief engineer for the Atlas Imperial Diesel Engine Co. in Oakland, Calif.

Now working for the Wayne Pump Co. in Fort Wayne, Ind., in the capacity of project engineer, **MELVIN N. OSBORN** had been connected with the Borg-Warner Corp. in Bellwood, Ill.

**RONALD JOHN RONAYNE** is now an engineer with the Oliver Corp. in Charles City, Iowa.

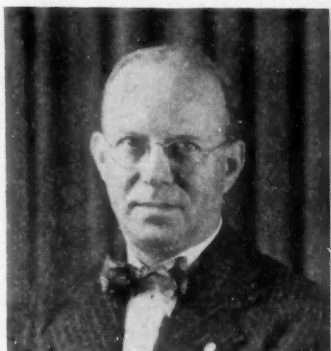
**ALBERT W. SCARRATT**, vice-president in charge of engineering and patents for the International Harvester Co., Chicago, has retired after more than 20 years' service with the company. Joining International Harvester in 1927 as chief engineer of motor trucks and coaches, he was elected to the vice-presidency in 1939. He is a member of the SAE Technical Board.

**LEONARD A. STEWART** was recently appointed to the position of chief engineer of the American Coach & Body Co. in Cleveland. For the past eight years, he was affiliated with Mack Trucks, Inc. as a body engineer in the Truck Division. Stewart is a member of the Body Standards, Body Activity, and Membership Committees of the SAE. He is also chairman of the sub-committee on Standardization of Moldings and Clips.

**LAURENCE LePAGE**, aeronautical engineer and author, has been appointed to an executive capacity with the Adrian Bauer Advertising Agency, Inc., Philadelphia. He was graduated in aeronautical engineering by London University and took graduate work in the Institute of Aeronautical Engineering. LePage joined the SAE in 1924 and has been active in the Philadelphia Section for many years.



## SAE Fathers and Sons . . . . .



**J. L. McCLOUD**, left, heads the Department of Chemical Engineering at the Ford Motor Co. in Dearborn, Mich. His son, **ROBERT A.**, is a design engineer for the Food Machinery Corp. in San Jose, Calif. The father is SAE vice-president in 1948, representing the newly-authorized Engineering Materials Activity.

If any SAE reader knows of SAE Father-and-Son or Husband-and-Wife combinations, both of whom are members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated—we don't want to miss any SAE grouping.

**ROBERT I. MINER**, chief engineer of Ryerson & Haynes, Inc., Jackson, Mich., with his late son, **ROBERT W.**, who passed away on Sept. 2. He had been a mechanical engineer with the Aeroquip Corp. of Jackson. The father joined the SAE in 1921.



President of Skinner Motors, Inc., Detroit, **RALPH L. SKINNER** with his two sons, **RALPH, JR.**, center, and **ROBERT T.** Ralph is an engineering student at the University of Michigan and Robert is assistant general manager of Skinner Purifiers Division of the Bendix Aviation Corp.



## SAE Husband & Wife . . . . .

Mr. & Mrs. R. W. Pointer who are in business together in the Pointer-Willamette Co. of Portland, Ore. **MAYBELLE POINTER**, an SAE member since 1944, is secretary and treasurer of the company and **ROBERT W. POINTER** is the president. He joined the Society in 1935.



## SAE Members Said . . .

"Competition is the economic counterpart of individual liberty" and requires "the banning of union monopoly just as we long since outlawed industrial monopoly" . . .

**GEORGE ROMNEY**, managing director, Automobile Manufacturers Association, Nov. 12, at eighth annual luncheon of Automobile Old-timers Association, New York City.

"Present day trucks in common with passenger cars, buses, street cars, airplanes, and almost every type vehicle provide infinitely more comfort for the operator than only a few years ago" . . . **B. B. BACHMAN**, engineering vice-president of the Autocar Co. and treasurer of the SAE, at The Pennsylvania State College, recently.

**HENRY BALFOUR**, previously senior test engineer for the Wright Aeronautical Corp. in Wood-Ridge, N. J., has been appointed project engineer on Mechanical Design for DeMornay-Budd, Inc. in New York City. Balfour is editor of the SAE Metropolitan Section "Accelerator".

**GEORGE ROMNEY**, managing director of the Automobile Manufacturers Association, has returned from the International Labor Office Metal Trades conference in Stockholm, as a delegate.

**NAT HAYNES** has recently joined the Aerophysics Department of North American Aviation, Inc., in Los Angeles, where he has been appointed supervisor of Propulsion Design. He was formerly design engineer with Pratt & Whitney Aircraft, and more recently, design engineer with Joshua Hendy Iron Works of Sunnyvale, Calif.

Appointment of **W. E. DAY** as director of research for Mack Trucks, Inc. has been announced by **W. M. WALWORTH**, vice-president and chief engineer for the company. Day had previously been chief metallurgist and general foundry superintendent for Mack. During the war, he served on the SAE War Engineering Board for Tanks.

Previously chief of the Experimental Flight Test Division at the Engineering & Research Corp. in Riverdale, Md., **EVERETT EDMOND HART** has now accepted the post of assistant general manager for the Specialty Tool Manufacturers in Belleville, Ill.

**EDWARD J. DEISLEY**, who has been executive engineer of the Budd Co., has been appointed special sales representative with residence in Detroit. He joined the Budd organization in 1919 in an engineering capacity. From 1926 to 1929, Deisley was in England assisting in the organization of Budd's former British affiliate, Pressed Steel, Ltd. He joined the Society in 1940.

**JAMES R. CORBETT**, who has had 45 years of experience in the field of lubrication, has been elected president of the National Lubricating Grease Institute. Corbett is vice-president of the Cato Oil & Grease Co. of Oklahoma City. He has been a member of the SAE since 1939.

**A. L. POMEROY** has become staff engineer for Thompson Products, Inc. in Cleveland. He will be concerned with development and sales engineering as related to both automotive and aircraft applications. Prior to this post, Pomeroy was manager of Engineering Operations at Ranger Aircraft Engines, Division of Fairchild Engine & Airplane Corp., Farmingdale, L. I., N. Y.

**A. S. DA MIANO**, export service engineer for the Electric Auto-Lite Co., New York City, has just returned from a 10-month visit to European, North African, and Middle East markets. He made surveys of all markets visited, and worked with management and personnel of official Auto-Lite Service Stations.

**ROLLAND D. KOENITZER** is now employed as an engineer with the Brown Fintube Co. of Elyria, Ohio. Before this post, he was foreman with the Thew Shovel Co., Elyria plant. In the past he had been connected with the McCord Corp., Detroit; Young Radiator Co., Racine; Perfex Corp., Milwaukee and the Harrison Radiator Division of General Motors Corp. in Lockport, N. Y.

**GEORGE M. ANGER** has been appointed Western States Representative for Scintilla Magneto Division of Bendix Aviation Corp. in Sidney, N. Y. Plans are under way to establish an office in San Francisco where he will maintain his headquarters.

**ANTHONY J. ZINO, JR.**, who had been eastern manager of the Lubrication Department of E. F. Houghton & Co., for the past five years, recently became assistant sales manager of the Industrial Sales Division of the Swan-Finch Oil Corp. His headquarters will be in New York City. Zino has also been connected with the Lubri-Zol Corp. as sales engineer and New York sales manager.

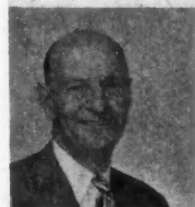




**EDWIN C. PAIGE** has been appointed head of the Fleet Section of the Technical Service Division of Ethyl Corp., to succeed **ERROL J. GAY** (below). Paige joined Ethyl Corp. in 1930. His first assignment was as a field representative and then fleet engineer in Baltimore. In 1935 he was transferred to the former New York Division with headquarters in Elizabeth, N. J., and in 1940 was assigned to the Fleet Section.



**ERROL J. GAY** has opened an office in the Fisher Building, Detroit, as a technical consultant. He had been with the Ethyl Corp. for 15 years and for the last several years had been manager of their Commercial Engine and Fleet Division. His activities will continue to be along lines somewhat similar to his past work, since one of his major clients is the Associated Ethyl Co., Ltd. of London. He will also act as consultant to Thompson Products, Inc., Cleveland.



**J. M. "MERT" MORROW** has been appointed vice-president in charge of sales for the Dayton Steel Foundry Co. in Dayton, Ohio. He has been with Dayton Steel for 20 years, in a sales capacity. He became a member of the SAE in 1945.



**J. V. BROWN**, having resigned from Messrs. Humber, Ltd., in Coventry, England, recently joined the Maudslay Motor Co., Ltd., Parkside, Coventry. He will serve in the capacity of service manager. The Maudslay Motor Co. are manufacturers of heavy commercial and passenger-carrying vehicles with both petrol and diesel engine power units.



**JERRY M. GRUTCH**, previously vice-president in charge of engineering and a member of the board of directors at the O. A. Sutton Corp., Wichita, Kans., has been appointed director of research and development for the American Car & Foundry Co. in New York City.

**COL. EDWIN E. ALDRIN**, of Montclair, N. J., has been appointed executive secretary of the subcommittee on manufacturing of the Congressional Aviation Policy Board. He is well-known in aviation circles and is a New Jersey Aviation Commissioner. Aldrin is on loan to the Subcommittee from the Atlas Supply Co. of Newark, N. J. SAE members serving in an advisory capacity to the Subcommittee are **ROBERT E. GROSS**, president of Lockheed Aircraft Corp., and **J. H. KINDELBERGER**, president of North American Aviation, Inc.

Knu-Vise, Inc., manufacturer of Knu-Vise toggle action clamping devices, has been merged with the Lapeer

Mfg. Co. in Lapeer, Mich. This company will now be known as the producer of Knu-Vise products. **F. W. LAMPE** has been retained as chief engineer.

Prior to becoming vice-president of maintenance for the Metropolitan Conveyor Corp. in Brooklyn, N. Y., **LEONARD TROY** was in the service of the U. S. Army.

Heretofore with the M. W. Kellogg Co., Jersey City, N. J., in charge of special processes, and of the work in the high temperature laboratory, **NORMAN L. DEUBLE** has now joined the metallurgical engineering staff of the Climax Molybdenum Co.

**T. E. FRANKENFIELD** has left the Laboratory Equipment Corp., Noblesville, Ind., to become vice-president of Frankenfield, Inc., dealers in tractors and farm equipment. This company has franchise for the Ford tractor and the Dearborn farm equipment for Hamilton County, Ind. Frankenfield is Meetings Chairman for the SAE Indiana Section.

**E. C. HOENICKE**, general manager of the Eaton Mfg. Co. Foundry Division, Detroit, and **RALPH J. TEETOR**, president of Cadillac Malleable Iron Co., Cadillac, Mich., were elected to the Administrative Council of the National Founders Association. They have both served for two years on the Association's Regional Committee and their election to the Administrative Council is in recognition of outstanding work in promoting the interests of the foundry industry.

## OBITUARIES

### ALFRED MARCHEV

Alfred Marchev, who was president of the Aircraft Screw Products Co., Inc., of Long Island City, N. Y., and former chairman of the board of Republic Aviation Corp., died on Nov. 28. He was 51.

Marchev was educated in Switzerland and received his engineering degree at the Polytechnic Institute in Zurich. He came to this country in 1919.

He was a well-known inventor and held more than 500 patents in his own name.

Marchev joined the SAE in 1943.

### VIRGIL ELTON LYMAN

Virgil Elton (Pete) Lyman, who had been manager of the Bearing Service & Supply Co., Salt Lake City, Utah, was killed in an automobile accident on Oct. 14, near Norwalk, Ohio. He was 43.

Lyman started work with the Bearing Service & Supply Co. in 1935. He held an honorary membership in the Anti-Friction Bearing Distributors Association, having been elected president this year.

He joined the SAE in 1945.

### CLARENCE WILBUR WINTHER

Treasurer of the Fresno Division of the Northern California Section, Clarence Winther passed away as the result of a heart attack on Nov. 9.

Winther was a partner with his brother in the Winther Brothers Garage in Fresno. The business was founded by the brothers and their late father in 1915.

# CALENDAR

## of Section Meetings

### Buffalo - Jan. 22

Buffalo Trap and Field Club; dinner 7:00 p.m. Gravity Spring Suspension of Vehicles - Mr. E. R. Boeck, president, Truck Equipment Corp. of Buffalo.

### Chicago - Jan. 19

LaSalle Hotel, South Bend, Ind.; dinner 6:45 p.m. Meeting 8:00 p.m. Shot Peening - What It Is and How It Is Used - K. H. Barnes, chief engineer, American Wheelabrator and Equipment Corp.

### Cincinnati - Jan. 26

Engineering Society Building; dinner 6:30 p.m. Good Roads and Highway Transport Make Possible the American Standard of Living - Fred B. Lautzenhiser, International Harvester Co. Sub-topics - Highway versus Air Transport, Motor Vehicle Taxation, The Motor Vehicle as Peace Time Utility. Motion picture - Monarchs of the Forest.

### Cleveland - Jan. 19

Cleveland Club; dinner 6:30 p.m. Developments in Motor Fuels - Charles D. Lowry, Universal Oil Products Co. of Chicago. Speaker-Sponsor - Raymond I. Potter, Standard Oil Co. Guest - R. J. S. Pigott, chief engineer, Gulf Re-

search and Development and president, SAE.

### Dayton - Jan. 20

Miami Hotel; dinner 6:30 p.m. Where and When to Use Die Castings - Ralph Wilcox, Gerity Michigan Corp.

### Metropolitan - Jan. 21

Pennsylvania Hotel; Meeting 7:45 p.m. Automatic Transmissions - L. H. Nagler, technical editor, Motor.

### Mohawk-Hudson Group - Jan. 27

Albany Garage; Meeting 8:00 p.m. Selection of Drivers and Vehicles for Fleet Operation - Robert Cass, White Motor Co.

### Northern California - Jan. 28

Officers Club, Treasure Island; dinner 6:30 p.m. Student meeting. Harley Drake, Technical Chairman.

Fresno Division - Jan. 5 Fresno Hotel; dinner 6:30 p.m. International Tractors - George Penkoff, International Harvester Co. H. R. Knott, Technical Chairman.

### Northwest - Jan. 23

Gowman Hotel, Seattle, Wash.; dinner 7:00 p.m. Over the Road Maintenance

Panel Discussion on Engines, Rear Ends, Preventive Maintenance Programs - Hugh P. Kanehl, fleet superintendent, Inland Motor Freight; Jean D. Barnes, superintendent of equipment, Petroleum Trans. Co.; Clarence A. Dyer, Lee and Eastes. General Discussion on all operating problems following formal panel discussions.

### Pittsburgh - Jan. 27

Mellon Institute; dinner 6:30 p.m. at Webster Hall across street from Mellon Institute. How to Select the Proper Vehicle - J. N. Bauman, White Motor Co.

### St. Louis - Jan. 8

Engineers Club; Joint meeting with Engineers Club of St. Louis and ASTE 8:15 p.m. Testing the Theory and Proving the Value Before Production - W. J. Davidson, General Motors Corp. Movie - General Motors Proving Ground in Operation.

### Washington - Jan. 13

The Broadmoor Hotel, Washington, D. C.; dinner 7:00 p.m. History and Development of Amphibious Equipment by the Armed Forces - General Fred S. Robillard, U. S. Marine Corps. Movies and slides.

### Western Michigan - Jan. 22

Hackley Art Gallery, Muskegon, Mich. Meeting 7:30 p.m. What's Wrong With Cast Iron - Arthur A. Weidman, director of quality and inspection, Detroit Diesel Engine Division, General Motors Corp. Assisted by Robert Terry, chief metallurgist, Detroit Diesel Engine Division, General Motors Corp. Slides to illustrate talk.

### Williamsport Group - Jan. 5

The Anglers Club, Newberry Pa.; dinner 6:45 p.m. Rocket Propulsion - Arthur W. Robinson, scientist, General Electric Co. Army released movies - Tests Made On The V-2 Rocket At White Sands, New Mexico.

## SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
ANNUAL and ENGINEERING DISPLAY	Jan. 12-16	Book-Cadillac, Detroit
PASSENGER CAR and PRODUCTION	Mar. 3-5	Book-Cadillac, Detroit
TRANSPORTATION	Mar. 30-31, Apr. 1	Bellevue-Stratford, Philadelphia
AERONAUTIC and AIR TRANSPORT	Apr. 13-15	New Yorker, New York City
SUMMER (Semi-Annual)	June 6-11	French Lick Springs, French Lick, Ind.
WEST COAST	Aug. 18-20	St. Francis, San Francisco

# Student Branch News

## Rensselaer Polytechnic Institute

RPI Student Branch members heard E. I. Billings, sales engineer for Socony-Vacuum Oil Co., Inc., speak on "Automotive Lubrication" at the second meeting of their school year.

Billings named as the four factors that must be considered in judging a lubricant: (1) Carbon control—for oil that is long-lasting may still be carbon-forming; (2) Piston ring seal—essential to prevent metal-to-metal contact with a resultant scoring of cylinder walls and to prevent combustion products being passed through to the crankcase; (3) Distribution to keep all surfaces well-lubricated; and (4) Resistance to viscosity changes and gum and sludge formation.

To achieve the desired marginal lubrication, he said, the lubricant must have an affinity for metal, to prevent metal-to-metal contact and excessive wear, especially as the engine starts. Detergent oils may mean cleaner engines, and freedom from ring sticking, but they cannot be reclaimed. Their other properties are not as good as those of the same oils without detergent. Oils, he added, build up acid content until they are detrimental to the engine block. Reclaimed oils must be used with care, because reclaiming does not necessarily remove acidity.

Billings concluded his talk with a movie showing basic fundamentals of lubrication and qualities of a lubricant.

## Lawrence Institute of Technology

Nothing is where you can use it, and nobody's where he wants to be. This, according to Gil F. Roddewig, explains the great American urge to travel. The experimental engineer from GMC's Truck & Coach Division, talking to L.I.T. Student Branch members at their Nov. 21 meeting, said that this desire to travel has resulted in the placing of an order for 1900 Greyhound Cruisers with General Motors. Greyhound has put well over a million and a quarter dollars into tooling and design alone of this particular model.

Upholstered reclining seats, foot rests, and green plastic shades on the windows help to make this cruiser the world's most luxurious and most expensive vehicle, Roddewig stated. An outstanding safety feature of the window is that a strong push on its top will cause the whole frame to open, providing an escape hatch in case of emergency.

Roddewig stressed weight as the most important consideration (from an engineering standpoint) in vehicle design. Use of aluminum wherever pos-

sible, and paring down to the absolute minimum still leaves a vehicle weighing 20,265 lb empty and 28,800 lb loaded. To carry this load it was necessary to have four rear tires. Then load had to be distributed so that 2/3 was centered on the rear tires and 1/3 on the front tires.

Another engineering problem faced by the makers was that of the wheel-housing seat. To eliminate bickering among passengers to determine who would get stuck with the seat over the wheel, Roddewig, said "we got out a bunch of slide rules and finally put the floor over the wheels." This left waste space under the floor. One engineer remembered complaints about luggage taking a beating on the roof, and our present under-the-floor baggage compartments came into being.

—by Edward Chester, Field Editor

The first membership drive of the L.I.T. Student Branch this year was eminently successful, with half of the 275 registration representing new members. Student interest indicates this number probably will increase toward last year's mark of 367.

At the first technical meeting, Prof. Milton Parsons, of the Mechanical Engineering Department, spoke on "Powder Metallurgy." Members were particularly interested in the composition and manufacturing processes involved in the products. Parsons devoted most of his talk to the self-sustaining bearing. He said cost keeps products made from powdered metals from becoming more popular.

The Detroit Stamping Co. in Highland Park, Mich., was host to a group of Student Branch members on Oct. 23 and 24. Dies of all types, shapes and sizes were examined and seen in action. The plant is set up to handle a complete die job from building the die to producing the finished product. In the toolroom they saw disassembling of simple, progressive, and compound dies. J. W. Figura, of production planning, explained how the die parts fit together and why the different types of die are necessary.

—by Harold Penn, Field Editor

## College of the City of New York

We used  $3.5 \times 10^{12}$  Btu's per day in the last war for aircraft only. This poses one of the limitations on possible fuels for jets, Don Heath of Socony-Vacuum Oil Co.'s Research and Development Laboratories told CCNY students at their Dec. 3 meeting.

Seven fuels—coal, alcohol, natural

gas, kerosene, gasoline, fuel oil, and residual fuel—produce enough Btu's per lb to make the list of applicants.

The other two major qualifications necessary for jet fuels are availability and ease of handling.

Heath ruled out petroleum products and natural gas because of handling difficulty. Coal was eliminated because it is not easily handled in any internal combustion engine. Production figures on alcohol prohibit its use.

Other requirements of a fuel were that it should not solidify at low temperatures and boil away at high temperatures. It must not be corrosive, and must be free from abrasives and dirt. It must have sufficient viscosity to lubricate the pumps it passes through. This self-lubrication is essential because of the high pressure to which these positive displacement pumps build up.

The fuel Heath finally selected is called jet propulsion fuel number one. J.P.1 is a kerosene type fuel with the same boiling range as kerosene. It is distilled from a naphthene base crude oil (no wax) and does not freeze or solidify at the low temperatures encountered under atmospheric conditions. It also has the desired viscosity for lubrication purposes. At present, J.P.1 production is only 10% of total kerosene production. This puts it very much under the required  $3.5 \times 10^{12}$  Btu's per day, but we have, or can convert, most of the facilities necessary to increase production tremendously.

The rest of Heath's talk was devoted to a description of jet propelled aircraft fuel systems, and to answering specific questions on fuels and fuel system design. Several students are working on jet engines as part of their engineering work, and were given some able assistance.

## Fenn College

Fenn Student Branch members were dinner-meeting guests of the American Society of Tool Engineers on Nov. 14 to see a moving picture on television and hear two speakers—J. H. Hartly, television director of Cleveland's new station WEWS, and Gordon Volkenant, associate director of research for Minneapolis-Honeywell Regulator Co.

Hartly said Cleveland's new television station is scheduled to start operations about Dec. 10, and represents an investment of close to a half-million dollars. It will broadcast 2-4 hr per day, five days a week. One of its features will be showing, by moving pictures, of news events that have taken place in Cleveland on the previous day. Of special interest was National Broadcasting Co.'s prediction that the next five years will see present AM radios superseded by FM and television.

"Gadgets, Gimmicks, and Electronics" was Volkenant's subject, and he accompanied it with innumerable sample demonstrations. Among the items: this Christmas President Truman will receive a "wrist watch" radio broadcasting set; the radio telephone transmitters in taxicabs have increased their take up to 400%; radar devices to help the blind are effective enough to detect a string 80 ft away; automatic pilots Minneapolis-Honeywell is working on will work without the guidance of a mother plane—an effective effort to take the buttons out of pushbutton warfare.

—by Robert B. Buhrow, Field Editor

Fenn Student Branch members joined SAE Cleveland Section on Dec. 8 for dinner and to hear a paper on "High Compression Ratios in Automotive Engines," presented by D. F. Caris and Archie D. McDuffie of General Motors Research Laboratories.

This discussion of the General Motors 12.5 to 1 compression ratio engine was composed largely of material from C. F. Kettering's paper "More Efficient Utilization of Fuels," published in the October, 1947, SAE Quarterly Transactions. Some of the facts and additions Caris disclosed were:

Production on this engine will depend on the ability of the oil companies to produce the higher octane fuels economically and in sufficient quantities;

The 12.5 to 1 ratio will probably be achieved by successive 1.5 steps upward;

The test engine was built as nearly as possible like a standard 6-cyl type, with all gains centered in economy of operation;

Economy gains of 43.3% over a similar stock car were achieved in 1200 miles of Detroit city driving.

The evening meeting was preceded by an inspection of a 6-cyl test model engine installed in a stock 1946 Oldsmobile at the Mechanical Engineering Laboratory of Case Institute of Technology.

—by Robert P. Buhrow, Field Editor

#### Texas A&M

During the first meeting of Texas A&M's Student Branch, Faculty Adviser Prof. W. I. Truettner described the organization and activities of the SAE, and officers were elected. He reported that Student members represent almost equally the mechanical and aeronautical engineering departments.

On Oct. 21, the Branch saw a film on the Cleveland Air Races, prepared by the Weatherhead Co., and featuring the Weatherhead Jet Trophy Speed Dash.

The SAE Student Branch met with Texas A&M branches of the American Society of Mechanical Engineers and

## Student Activity Grows with SAE Sections' Aid

THE SAE Enrolled Student's stake in SAE has become more important and more rewarding in recent years than ever before. Enrollment has grown in one year from 1055 to 2618. Partly cause of this growth, and partly effect, has been an encouraging increase in SAE Sections' awareness of the importance of enrolled students and of the Society's responsibilities to them.

Section aid to student branches manifests itself in many ways. Students are welcomed at all Section as well as National meetings, often as guests of Sections. Most Sections help faculty advisers and student officers to set up effective organizations. Advice and assistance are given in arranging meetings programs.

This cooperation derives from general recognition that one of the greatest nonmaterial benefits SAE gives student engineers is through making it possible for them to associate with older, experienced members of the Society.

Here is how some Sections devote their time and knowledge to aiding Student Branches, according to reports received by SAE Journal.

- Twenty-eight Sections and Groups have a special vice-chairman for Students (14 are pictured here)

- Section holds one big meeting a year for students (Cleveland, Detroit) or occasional meetings on school campuses (Oregon, Mid-Continent)

- Students may sit in on Governing Board meetings to learn techniques of organization and planning meetings (Wichita, Metropolitan, Cleveland)

- Sections sponsor student paper contests (Southern New England, Metropolitan)

- Section members give papers before Student Branch meetings on subjects of special interest to students, such as elements of design (Metropolitan, Mid-Continent, Milwaukee, Spokane-Intermountain, Colorado)



Top (l. to r.) Norman C. Penfold, Armour Research Foundation (Chicago); Peter Kyropoulos, California Institute of Technology (Southern California); and George Tanker, Weatherhead Co. (Cleveland). Center: E. K. Harris, General Motors Institute (Detroit); W. A. Wiseman, Continental Motors Corp. (Western Michigan); and David Fisher, Tufts College (New England). Bottom: Carl Habermann, Socony-Vacuum Oil Co., Inc. (Metropolitan); and Joseph Liston, Purdue University (Indiana)

- Section sponsors plant visits for Student Branches (Milwaukee, Southern California, Metropolitan)

- Section sponsors student attendance meetings, dinners (New England)

Meanwhile, responsible SAE Section members are constantly coming up with ideas and suggestions for ways and means of formalizing services to Student Branches. The Council's Advisory Committee has taken on as one of its projects the problem of aiding Student Branches in their work.



Top (l. to r.) Robert H. Fowble, San Diego State College (San Diego); R. T. Howe, Drackett Chemical Co. (Cincinnati); H. R. Grigsby, Oklahoma Gas & Electric Co. (Mid-Continent). Bottom: John D. Hull, Jr., Walter Kidde & Co., Inc. (Kansas City); Tom Salter, Cessna Aircraft Co. (Wichita); and Neils C. Beck, Parks College of Aeronautical Technology (St. Louis)

the Institute of the Aeronautical Sciences on Nov. 6 to hear a discussion of "Manufacture, Physical Properties, and Operating Characteristics of Fuels for Gasoline and Diesel Engines," by Louis E. Endsley, research engineer for Beacon Laboratories of the Texas Co. Endsley used slides for an effective illustration of his talk.

-by James E. Francis, Secretary-Treasurer

#### University of Wisconsin

The SAE Student Branch at Wisconsin was established in 1938 and continued until 1942. At that time, lean membership of the war years made necessary a temporary affiliation with the ASME Student Branch. Both functioned under the Mechanical Engineering Society of Wisconsin. Present high enrollment has made possible recent reestablishment of the SAE Branch as a separate organization.

At the Nov. 19 meeting, a steam-driven automobile was the object of much curiosity and a lively discussion when Charles K. Keen, president of Keen Mfg. Co. of Madison, demonstrated his novel vehicle.

Student engineers were impressed by the noiseless operation of the 2-cyl compound condensing engine that develops 100 hp. The engine is located in the rear of the car, geared to the rear axle without an intervening gear-shift mechanism. A hand-operated throttle controls the engine's output directly, and so rapidly that the "Steamliner" can attain a speed of as high as 70 mph in a few seconds.

When the car is parked, a pilot light automatically sustains a pressure of 650 psi in a vertical fire-tube boiler under the hood. According to Keen, the steam auto averages between 16 and 20 mpg of kerosene.

Slow engine speed and antifriction bearings make for long engine life. The engine has only 15 moving parts, and develops power equal to that of a conventional 8-cyl engine.

Keen said the company has no present plans for mass production, since further experimenting is being done. But he feels that steam cars will have a definite place in future automobile production.

-by Bernard Kloehn, Field Editor

#### California Institute of Technology

Members of the Caltech Consolidated Engineering Societies gathered on Oct. 6 to hear one man's opinion on "The Future of the Aviation Industry."

L. D. Bonham, chairman of SAE Southern California Section, introduced Speaker Heath McDowall of Pacific Air Motors, who made a few forecasts.

T. P. Wright, he said, forecasts 400,000 private aircraft by 1950 - in spite of the fact that in 1947 only half as many planes were produced as in an equivalent

period in 1946. The slump comes from an influx of surplus military aircraft.

Commercial airlines, McDowall said, have overpurchased aircraft. The Air Transport Association reports 913 aircraft in service on scheduled airlines today. They forecast 1500 in service by next year.

New craft, he predicted, will be larger than present craft. The Martin 202 may replace the DC-3, the Consolidated 240 may go into passenger service, and the DC-4 may assume freight-hauling duties.

McDowall cited his own engineering experience to show how engineering thinking processes as well as actual knowledge are valuable in industry, and assured students of a continuing demand in the aircraft industry for men in sales, service, management, design and research.

-by Warren Marshall, Secretary

#### Northrop Aeronautical Institute

"A good engineer is a normal intelligent human being trained to think analytically," Mac Short, vice-president of Lockheed Aircraft Corp., told Northrop students at their Oct. 9 Student Branch meeting.

The basic requirement of any engineer, Short said, is that he be able to think and to solve problems analytically. Formulas and classic book rules are simply a way to organize and simplify commonly-used principles and calculations. Any engineer who follows such rules blindly will find himself unable to follow through any original research or ideas. The ability to think constructively should be applied to the engineer's relationships to other people as well as in his work.

Once an idea is born or a problem is solved, the solution or idea must be sold to other people if any value is to be gained from the work. Thus the engineer must be a good salesman in expressing his views.

Short pointed out that every good engineer must know his limitations in mental ability, experience and education. If he realizes these limitations, he can confine his work to appropriate subjects or plan an intelligent course of study to increase his ability.

A good quality for any engineer to cultivate is the ability to finish a job - however tedious or difficult. May people have brilliant ideas at times, but it takes a great deal of laborious investigation and research to produce a successful airplane or any other product. The engineer should be able to work by himself, if possible, in order to find and correct his own mistakes. Problems in industry do not have the definitely-correct answers found at the end of text books.

Short said that beginning engineers

should not be in too great a hurry to start on some particular kind of work. It is better to look around for a while.

The organization of a typical engineering department and the procedure followed by the industry in designing a plane were explained to members of the NAI Student Branch at their Oct. 22 meeting. Speaker was C. L. Bates, design administrator for Northrop Aircraft, Inc., and liaison engineer for the school.

After breaking down the organization of a typical aircraft factory, Bates went into detail in dividing the engineering department into its components to give members an insight into the functions and activities of each division.

He discussed such varied functions as stress, design, drafting, lofting, filing, and testing. Details of the design of an airplane were of particular interest. The work was broken down into various stages and explained briefly.

First stage is the "Proposition Stage." Here the company has received the information from the customer and must decide where or not to bid on it. If it is decided that a bid will be submitted, the various design groups suggest preliminary features of the plane. A three-view drawing is submitted, together with performance and cost estimates.

After the bid has been made, a waiting period ensues until an award is made. When the award has been made, the plane enters the "Preliminary Design Stage." In this stage, the aerodynamics department makes up calculations and submits the basic information on the project. All work in this stage is of a general nature with little attention to detail.

Next stage is the "Detail Design Stage" where the details are drafted up. Lofts of the plane are made and detail drawings begun. Shortly after this the plane enters the shop in the "Production Stage."

In its progress through the various stages the plane may change considerably in certain features. Weight is the aspect most likely to change, because of changes in the estimated fuel necessary for performance and in equipment going into the project. An example was cited in which the preliminary calculations showed gross weight to be about 70,000 lb. As the plane progressed, weight varied between 50,000 and 150,000 lb. The final weight figured at 72,000 lb. This was explained as a "lucky guess." Quite often, Bates, admitted, it works the other way around.

-by M. G. Cornford, Field Editor

# SAE

# SECTION MEETINGS

## Tells of New Developments In Motor Coach Engineering

by ROBERT BEST, Field Editor

**BUFFALO Section, Nov. 25**—Members met at the Buffalo Trap and Field Club for this meeting, a "Twin Coach" night at which many officials of the company were present. Speakers included John J. Lee, vice-president and general manager; Earl Lenz of Engineering & Production; Arthur Butler, chief engineer of the Buffalo Plant; Carl Maundrel of the Public Relations and Sales Contracts Division, and William DeCapua, chief engineer of the Kent, Ohio plant.

DeCapua, who was principal speaker on the program, described requirements of modern motor coaches. Motor coach performance, he said, must be adequate to meet the demands of the traveling public and be in keeping with other forms of transportation.

DeCapua said that 1927, when the modern type of coach emerged, saw the first twin-engine coach—built to give faster operation than could be attained with single engines then available. When more powerful engines were built, coaches were again manufactured with single engines.

Today Twin Coach makes both single and double engine coaches, equipped with a new engine designed especially for the job. The engine has features that permit it to lie on either side with accessories on top and to drive either right or left hand. It develops 180 hp with an 8:1 compression ratio on motor gasoline, and fuel consumption is under 0.5 lb per hp-hr over the entire range of operation. This is made possible by a patented combustion chamber design.

The same engine has been used in many marine installations, and was the powerplant of the "So Long Jr.," which developed 325 hp at 4000 rpm super-

charged, and won the President's Cup and many other racing trophies.

Modern coaches, he said, usually have this engine mounted amidships under the floor, where it does not interfere with payload. Latest development is a two-unit coach with a hinge in the middle, carried on three axles. Both front and rear axles steer so that the rear tires follow exactly the tracks of those in front. The drive is through the middle axle, which is mounted on the front section. This coach, while it is 47 ft long, can turn in a radius of 35 ft and can weave in and out of heavy traffic with the ease of a motor car.

## Hear Results of Diesel Road Tests

by C. W. SISSMAN, Jr., Field Editor

**SALT LAKE CITY Group, Oct. 13**—Members at this meeting, held in Springville, Utah, for the benefit of the many Springville members of the Group, heard Frank Forrest of California Research Corp. speak on "Instrumentation and Road Testing." His paper and slides dealt with development and testing of new types of lubricating oil used in diesel engines in large interstate transport trucks.

According to Forrest, the best lubricating oil of 10-15 years ago was a straight mineral oil. Newer oils and Heavy-Duty oils today are of a straight mineral or asphaltic base crude with added compounds. These compounds or additives are of various kinds, and accomplish such various ends as to inhibit sludge, lacquer deposits, foaming, corrosion, and oil oxidation.

There are three classes of oil on the market today: Regular (uncompound-

ed); Premium (usually compounded against oxidation); and Heavy-Duty (compounded with one or more of the additives mentioned).

Operating temperature, he said, is very important to oil condition. Running an oil hot (above 180 F) will result in oxidation and corrosion; cold oil (below 180 F) will cause water condensation and sludge deposits. A 20 F increase in oil temperature doubles the oxidation rate of the oil. The use of Heavy-Duty oil is mandatory in heavy-duty operations to reduce deposits.

The field tests on which Forrest's conclusions were based were conducted by two methods—random and comparative. The random tests were those in which one oil was used throughout the test. In the comparative tests, various oils were used with known test oils to obtain conclusive data.

Test periods averaged 70,000 miles. Before the test began, engines were completely overhauled and accurate measurements taken of all moving parts where wear might occur. After the test period, engines were again disassembled and a comparative set of measurements taken. These measurements, along with data obtained from the frequent analysis of the oils, were plotted in graphical form and the results recorded. Forrest showed slides presenting conclusions obtained in both graphical and data form.

A few of the results and causes observed in these tests were:

1. Acid number and resulting corrosion increases with fuel dilution.
2. Bearing corrosion is caused by acids, fuel dilution, and high oil temperatures.
3. Oil consumption results from oil ring clogging and engine wear.
4. Lacquer deposits on piston and liner come from oxidized oils, unstable oil, or high oil temperature.

5. Ring sticking is caused by lacquer or carbonaceous deposits or improper clearances.

6. Scratching or scoring is caused by contact of parts brought about by wrong oil type, abrasives in oil, or lack of correct engine clearances.

7. Sludge is brought about by water in oil, fuel dilution, low operating temperatures, and carbonaceous deposits.

## Calls Flexibility Great Turbine Asset

by WARREN HASTINGS, Field Editor

CANADIAN Section, Oct. 15—Important advantage of the gas turbine, and one often overlooked, is flexibility. This attribute greatly enhances its usefulness as a prime mover, D. G. Shepherd told members at this meeting.

Shepherd, who spoke on "Some Developments in Gas Turbine Design," is chief development engineer for A. V. Roe, Canada, Ltd., and was associated with Commodore Frank Whittle in his pioneer developmental work on gas turbines.

Shepherd broke this quality of flexibility down into three phases:

1. In initial design. Various phases of the cycle are performed in different components, and many different arrangements are possible to produce the required performance. If first cost is important, a simple cycle may be most suitable; if running cost is important, the cycle may be as complex as necessary.

2. Practical development. Main components can be independently tested without complete assembly, and up to a point a great deal can be done with scale models.

3. Replacement of worn, failed or obsolete parts. Improved components may be substituted to increase performance without scrapping the whole plant, and replacements are relatively easy.

Other advantages: greater power-weight or power-volume ratio in most cases; ability to use a wide range of fuels; absence of vibration transmitted to foundation; ease of maintenance; and low lubrication costs.

Among its disadvantages, Shepherd

said, are poor economy, except in the most complex cycles; efficiency below that of the oil or gasoline engine (partly because unproven reliability and endurance make engineers cautious about basing designs on high stresses and temperatures); necessity for large duct sizes (and consequently for filtering) because of high air use; and sensitivity to intake air temperature.

Shepherd named the peak-load or standby unit as an important application for the gas turbine—one in which its advantages of low capital cost, simplicity, and immediate availability are of great value. He suggested the simple cycle type with a centrifugal compressor for such duty, because it can very possibly be made cheaply and can supply large quantities of power in a relatively small framework. It also has considerable use as a transportable unit in locations where it is uneconomical to install transmission lines, and where a permanently-installed prime mover requiring solid foundations is impossible.

Shepherd named other uses in which gas turbine characteristics would be valuable, and concluded his complete analysis of turbines and turbine components with a prediction that, although the gas turbine can never supplant all other types of prime mover, it will have an increasing sphere of usefulness, since its development is still in the initial stages.

A feature of the meeting, held in the ballroom of the Royal York Hotel, was the presentation on behalf of some Section members of aeronautical smokers' companion sets, appropriately engraved, to Section Member Dr. O. W. Ellis, director of the Department of Engineering and Metallurgy of the Ontario Research Foundation, and Prof. E. A. Allcut, chief of the Department of Mechanical Engineering of the University of Toronto. Gift was in grateful appreciation of their distinguished World War II and subsequent services to the Affiliated Engineering and Allied Societies as successive presidents.

Allcut, discussing Shepherd's paper, referred to recent developments overseas in gas turbines, and pointed out that solutions must be found for the serious problems involved in the use

of pulverized coal and heavy oils before such engines consuming such fuels can be deemed to be "in the realm of practical politics" commercially.

## Review Test Results of High-Compression Engine

by A. M. MILEY, Field Editor

PHILADELPHIA Section, Nov. 12—Progress report of a comprehensive test program on high-compression engines was presented at this meeting by two members of GMC's Research Laboratories Division, D. F. Caris and A. D. McDuffie.

The authors described the program as growing out of a general postwar need for making better engines, and a specific desire for answers to such questions as:

1. Does a high compression engine have to be rough if properly designed?
2. Is the gain in efficiency as represented by mpg and increased performance worthwhile?
2. Will increased friction result from high compression ratios and offset much of the gain in efficiency?
3. What will be the octane requirement of engines designed for high compression ratios?
5. What is the ignition problem at high compression ratios?
6. Are combustion chamber deposits more critical at high compression ratios?

The 6-cyl, high-compression engine used was based on data obtained on a preliminary high-compression single-cylinder engine, plus diesel experience. A 12.5 compression ratio was chosen because single-cylinder data had shown that most of the efficiency gains on this cylinder construction could be obtained at this ratio. Plan was to build an engine that could operate at this ratio and still be as acceptable to drivers as current engines. This would show that it would be possible to use such high compression ratios in an automobile engine when fuels are available at the gas stations. If, when new engine designs are made, the economics of high compression ratios are taken into consideration, these engines can always be adapted to the current available fuels. As suitable fuels become



CINCINNATI SECTION. Shown at dinner preceding the Nov. 13 meeting are SAE President C. E. Frudden, Section Chairman Ralph E. Morrison, Hollister Moore, manager of SAE Sections and Membership Department, and Wilburn E. Meyer. Past-chairman Meyer received a certificate of appreciation for his work during the past Section year.

available, the compression ratio could be increased without other major engine changes. This would save on costs for new engines. The problem, then, was to determine what the foundation has to be to carry the maximum loads the engine would ever be asked to carry. The engine is a long range experiment—not a finished production engine.

A number of significant conclusions have already been derived from road experiments with the 6-cyl, high-compression ratio engine. Among those reported:

- Increases in economy of 35 to 40% can be expected when compression ratios are raised to 12.5 to 1.

- With proper attention to structural design, an automotive engine can be operated at compression ratios as high as 12.5 to 1 without sacrificing smoothness.

- With reasonable attention to design factors affecting knock, it will be possible to build high-compression automotive engines that can utilize to advantage the sensitive types of high octane gasoline the petroleum industry is able to produce most economically by present refinery technology. Under these conditions, a sensitive type fuel with an octane number of about 99/87 will operate satisfactorily in engines at 12.5 compression ratio.

- Thousands of miles of driving under widely varying conditions have shown that the problem of combustion chamber deposits is no more critical in high compression than in low compression engines.

While the trend toward higher compression ratio must be gradual and orderly, the authors concluded, this trend can be accelerated if the required correlation between fuels and engines

**CANADIAN SECTION.** Dr. O. W. Ellis (left) and Prof. E. A. Allcut (right) receiving their engraved aviation smokers' standards at the Section's Oct. 13 meeting. Presentation, in recognition of World War II and subsequent services to the Affiliated Engineering and Allied Societies, was made by Warren Hastings, Section vice-chairman and vice-president of the Affiliated Engineering and Allied Societies



**PHILADELPHIA SECTION.** Above: Darl F. Caris, of General Motors Research Laboratories, points out some of the special features of the Kettering high-compression engine to Section Chairman Robert Kinnebrew at the Oct. 8 meeting

Below: John C. Moxey, Jr., 1946-47 chairman, receives a certificate of appreciation and recognition for his work and the congratulations of the present chairman, Robert Kinnebrew



is taken into consideration while new engine designs are being made up. Further gains are possible as new developments come in the petroleum and automobile industries—for we have not reached the limit of engine efficiency.

Fuels side of the problem was analyzed during discussion following the paper by John G. Moxey, Jr., of Sun Oil Co., who called the General Motors engine "a real mile-stone in the development of automotive transportation."

C. F. Kettering has called his high-compression engine "a long-range experiment, and not a finished production engine."

"I think," Moxey said, "that the same thing is true of the 100 octane fuels to run it. We all know how to make such fuels, and we are making them now in really large quantities. But we are using them to blend in with other lower quality materials to give us a finished production gasoline of the proper quality for the cars which are now on the road."

But, he said, with the present state of the art, octane numbers are expensive. Use of these high quality materials alone as a finished gasoline seems to him to be some years off.

Theoretically, however, a 12.5 to 1 ratio would give about a 35% gasoline saving. Taking 35% of a hypothetical 22¢ gasoline leaves the fuel technologists 7¼¢ to work with. If they can give the motorist gasoline that costs less than 29¼¢ per gal, he will be able to save money.

Going back a step, the refiner will have more than twice that 35% to work with.

Moxey admitted optimism about possibilities of the high compression engine and the fuels to run it. But he feels the process will be gradual, and that the 12.5 to 1 engine will probably stay in the experimental stage for several more years.

## Kettering Engines Within Three Years?

by WILSON B. FISKE, Field Editor

CLEVELAND Section, Dec. 8—A record attendance of members and guests at one of this Section's most interesting meetings heard General Motors research engineers sum up results to date of experiments on new high-compression engines.

D. F. Caris and Archie McDuffie told of results in increased economy, better weight-per-horsepower, and ability to use future high octane fuels, and then made engineers present prick up their ears by quoting a prediction by General Motors President C. E. Wilson:

"We are going to produce some Kettering engines, there is no doubt about it. It takes a little while, though. We think we understand the problems.

"We have made a number of these engines. We have run them on our Proving Ground. We have the problem of keeping in step with the petroleum industry, as to when the higher octane fuels will be available, broadly, throughout the country. We can't tell you exactly when that will be. I don't think it will be too long in the ordinary terms of motorcar improvement; within two or three years, anyway, maybe sooner.

"We think it is a very worthwhile thing because if we can get the same amount of power from fewer gallons of gasoline, it is like discovering new oil fields, it is part of the conservation of natural resources, and we are going to push it along one way or another."

The high-compression General Motors car described was on display during the afternoon at the Case Institute of Technology in Cleveland.

## Reports on Britain's Vast Turbine Program

by WILSON B. FISKE, Field Editor

CLEVELAND Section, Nov. 10—The British are conducting an aggressive and vast development and utilization program on gas turbine engines, Dr. Walter T. Olson told the Cleveland Section.

The chief of the Combustion Branch of NACA's Flight Propulsion Research Laboratory described his trip surveying the British aircraft turbine industry as a member of Gen. E. M. Power's team of six specialists.

British turbojet engines, Olson reported, used simple thermodynamic cycles and conventional mechanical arrangements. Two different engines of reasonably good weight and economy are in service use and appear to have better durability than American engines—although they give only about half as much thrust.

Several British turbojet engines of about 3500 and 5000 lb thrust have been quite fully developed, and work is being expedited on a very light-weight, highly-efficient simple unit of 6500 lb thrust. At least one English company anticipates commercial use of the turbojet in the very near future.

Turboprop engines also work on the simplest possible thermodynamic cycles, but follow a great variety of mechanical systems and air flow arrangements—because, Olson feels, the British are trying to investigate all possibilities, and are unwilling to drop any of these projects until they are more certain of the course of development of the turboprop.

One highly unconventional engine is being built, and it is the only engine in Great Britain being developed for long range or long duration flights. It is based on a 12-cyl, 2-stroke diesel engine compounded with a turbine.

Power for compression of the air for the diesel is shared between the diesel and the turbine, and both share the power driving the dual-rotating propellers.

Axial and centrifugal compressors are used about equally, Olson said. Centrifugals are designed largely from experience with superchargers, and axials are designed from cascade data that are meager in extent and low in accuracy, as well as from the designer's own experience and ideas. Almost every conceivable method of manufacturing axial flow compressor blades is being tried, but none has provided blades cheaply and in bulk.

Combustors for British aircraft gas turbines have been largely developed by a single company. As a result, a single set of design principles has evolved through this company's continual cut-and-try experimentation. Main handicap to the research and development program is lack of completely versatile air supplies.

Turbines are designed from steam turbine experience or from meager turbine cascade data. Design is always compromised for manufacturing convenience. English research and development on high temperature materials for turbine blades is centered around cobalt, chromium, columbium, and titanium based alloys. No experiments have been performed with blade cooling.

Olson's summary revealed:

- The British have a clear lead over the United States in development and practical application of the aircraft gas turbine, particularly for the turbo-prop engine. Primary reason is their earlier start: the major part of the aircraft engine industry in the United States kept to the reciprocating engine until the war's end.

- As to maintenance of this lead, England is handicapped by not having available the large and versatile air and power facilities required for testing compressors, combustors and turbines. Further, there is no on-the-ground facility for evaluating a full-scale engine under different simulated flight conditions. The flying test beds England uses are not a wholly satisfactory solution, and economic conditions probably will prevent construction of needed facilities for at least three to five years.

- This country has the required facilities for research on and development of components and engines, and more are becoming available. In addition, its industry has mastered the assembly line techniques of mass production in a way that England never has. Olson feels the United States may rapidly close the existing gap and move out ahead in the development and utilization of this new prime mover, the aircraft turbine engine.

# SAE Section Chairmen

This is the fifth group of biographies of 1947-48 Section Chairmen, written for SAE Journal by field editors. Three more will appear next month.

## STEVENS

### .... of Washington

Hoy Stevens is an experienced engineer in commercial motor vehicle maintenance and an authoritative writer on technical and maintenance subjects. Chief of the Equipment and Maintenance Section of the American Trucking Associations, Inc., he is also technical editor of that organization's "Transport Topics," a national weekly of the motor freight hauler.

His articles have appeared in leading trade magazines, including "Fleet Owner" and "Bus Transportation" for a number of years. In 1944, while he was serving in the Maintenance Section of ODT, he wrote a booklet entitled "Care and Use of Synthetic Tires," tailored to the needs of tire service men. He was also technical consultant for a series of training films on preventive maintenance made by the U. S. Office of Education.

Stevens first got his hands in engine oil as an airplane mechanic with the AEF in France during World War I. After his discharge from the Air Corps he reentered Case School of Applied Science and was graduated with a BS in mechanical engineering. Post graduate work gave him a degree as a mechanical engineer, and he holds an MS from Western Reserve.

His first job was with the old Cleveland Railway Co., a transit company, where he worked through many departments to the position of superintendent of bus maintenance. He is a professional engineer registered in Ohio. While in Cleveland, he was treasurer and a director of the Cleveland Engineering Society.

Stevens is currently a member of two SAE committees - Vehicle Nomenclature and Evaluation and Classification of Transportation Engineering Formu-

las. His home is in Silver Spring, Md., where he belongs to a luncheon club known as the "Road Gang" and plays a poor game of golf.

- by Hyman Feldman, Field Editor

## MIKKELSON

### .... of Hawaii

David H. Mikkelsen first found his way to Hawaii with the U. S. Army, and the second time through the SAE Placement Service. As a maintenance and transportation officer with the Seventh Infantry Division, he stayed there from 1943 to V-J Day, after taking part in the invasion of Attu.

Mikkelsen, who just recently passed his thirtieth birthday, joined SAE in 1942 as a junior member. An SAE Placement Service contact sent him to Honolulu as an automotive engineer for Honolulu Rapid Transit Co. in 1945. A year later he became superintendent of automotive equipment. He inherited rolling stock worn out from the overload of war years and a constantly changing green personnel that had to be trained in bus operation. It was a man-sized job - and Mikkelsen tackled it with the determination he brings to every job he undertakes.

He was born and brought up in Montana, and got his BS in mechanical engineering from Montana State College. He took ROTC training while he was in college, and was commissioned second lieutenant in the Infantry reserves. After graduation, he worked for Montana-Dakota Utilities Co.

Mikkelsen likes all types of athletics - particularly football (in which he was a three-year letterman), baseball and basketball. He and his wife bowl every week, and he is considering taking up golf since he just missed the booby prize in the only golf match he played.

He enjoys a friendly poker game, and it is rumored that when it comes to cribbage he can beat the man who invented it.

He adds to his SAE work - which he takes very seriously - membership in the Junior Chamber of Commerce, the Engineering Association of Hawaii, and the Honolulu Representative Club.

- by Louis M. Eihl, Field Editor

## SLATTERY

### .... of St. Louis

Robert O. Slattery has divided his career between Shell Oil Co. and the Army. He joined the company's Industrial Relations Department in 1930, and soon transferred to the Sales Division as lubrication engineer.

He was given a leave of absence in 1942, and with the rank of captain was appointed chief of the Instructions Section, Fuels and Lubricants Branch. In 1943 he went to Detroit as chief of the Fuels and Lubricants Section, Maintenance Division O.C.O.-D.

He has served as an Ordnance representative on a number of SAE committees, cooperating with the Ordnance Department on problems of lubrication, rust prevention and other factors affecting maintenance.

After his discharge, he returned to Shell and is now division lubricants engineer.

Bob was born in St. Louis - an only son with four sisters. He is a graduate of the Mechanical Engineering School of Washington University at St. Louis, and now lives in suburban Glendale where he raises fine roses. He is married and has a 15-year-old son who shares his hobby of fine guns and target shooting.

- by A. K. Miller, Field Editor

Left to right:

Hoy Stevens

David Mikkelsen

Robert Slattery





## FRED M. YOUNG TOURS SECTIONS

### Seven West Coast Sections Hear Young Radiator Co.'s President Speak on Engine Cooling Developments

Though heat rejection for internal combustion engines has not received the engineering attention required for the development of efficient, properly-proportioned cooling systems, research is being undertaken on a greater scale than ever before. So said Fred M. Young, president of Young Radiator Co., in a talk presented during November to seven SAE Sections and Groups.

Young spoke on "Developments in Engine Cooling" before Spokane-Intermountain, Northwest, Oregon, Northern California, and Southern California Sections, and Salt Lake City and British Columbia Groups. Twenty engineering students from the University of British Columbia, members of a new student branch, were special guests of British Columbia Group.

Cooperation between vehicle, radiator, and engine manufacturers is "very close," Young continued, and detailed attention is being given to design and developments in wind tunnel, road and fleet tests. Automatic manufacturing techniques contribute their share to increasing quality and lowering costs—with the result of better design and developments in the radiator field.

Young used slides to drive home his argument that "every make and model of engine will have a different heat rejection because of design types and differences." Of particular interest to British Columbia loggers who use internal combustion-engined donkeys was his warning to industrial users of automotive engines that utmost consideration must be given to cooling systems when powerplants are changed.

To determine actual requirements, he said, tests should be run for given models. One major automobile company, he reported, selects its radiators on the basis of a heat rejection value of 12 Btu per min. per cu in. engine displacement at 2000 rpm. On the newer automotive type of engine, as efficiency has increased the heat rejection rates to the coolant have been reduced. Diesel engines require less heat rejection, and although a diesel usually may be substituted for a gasoline engine without changing radiator size, it is generally necessary to increase radiator size when switching the other way. Young's heat rejection tabulation showed:

Engine	Btu/min/bhp
Automotive type gasoline	40
Large industrial type gasoline	60-65
Average diesel	50
Large diesel (railroad type)	35

"Truck and bus engine horsepower output has been increased—and to a greater extent than heat rejection rate has been decreased," Young said, "while the space available for the radiator has remained constant." This has required the development of "packed" surfaces that have fin spacing as high as 10 per in. and tube spacing as close as  $\frac{3}{8}$  in. across the face of the core in plate-type cores. Staggered spacing of tubes (mandatory for maximum efficiency, according to Young) has been a further resort, as has the development of pressure caps for sealed cooling, in which pressures of 2 to 5 psi are generally used.

Engine manufacturers, he said, have been slow to utilize this major cooling advancement of sealed or pressure cooling, although it is widely and successfully used on buses. It minimizes coolant evaporation and surge losses; cuts down formation of crankcase sludge at high operation temperatures; and, in addition, cuts down required radiator surface. In the pressure cooled system, the radiator's cooling capacity is increased about 10% for each psi of radiator pressure. One psi pressure will increase about 3 F the temperature that causes the system to boil.

Excessive fan horsepower consumption at high speeds was named as a pressing problem after 40 mph, when fan speed begins to increase directly with engine and vehicle speed, and fan horsepower increases as the cube of speed. The average automotive fan, he estimated, seldom exceeds 45% mechanical efficiency. He suggested a fan shroud, which at high speeds will increase output as much as 15%; or some type of automotive adjustment—a variable pitch fan thermostatically controlled, or an electrically-driven, thermostatically-controlled fan.

Advice for better cooling systems included:

- Use of oil coolers in all vehicles. Water-cooled oil coolers in particular, he said, have gained efficiency through use of removable agitators that cause more oil to contact the tube surfaces.
- Fan shrouds—a necessity for stationary applications. The curved shroud is superior to the flat type with a hole cut in it. The fan should have about  $\frac{1}{4}$  of its cross section outside the shroud for best efficiency. Large fans with good shrouds and airfoil sections attain efficiencies of 65%.
- A surge tank or baffles in the

radiator to prevent surge losses caused by the impact of a "slug" of water on the relief valve in the pressure cap, brought about by either road shock or rapid acceleration or stopping.

Climaxing a comprehensive and complete description of crankcase cooling problems in automotive engine power units ranging from passenger cars to heavy trucks, buses, stationary engines, farm tractors and earth-moving equipment, Young finished his address with advice on radiator maintenance and service. Most cooling troubles are caused by faulty gaskets and pump seals, he said; and most of them can be corrected in the field.

Failures caused by excess vibration require changing the vehicle mounting. Because iron and steel used in cooling system construction are susceptible to corrosion, lack of attention to rust and scale means a gradual reduction in heat transfer rate. Rust particles are carried into the radiator where they plug the tube. He suggested cleaning and boiling frequently, since plugging can happen in as little time as four months.

"The time to start cooling system maintenance is when the system is new," he emphasized. "It should be filled with clean tap water to which should be added a good commercial corrosion inhibitor. Distilled water should not be used unless it has been aerated."

—by John B. Tompkins, British Columbia; Clyde W. Sissman, Jr., Salt Lake City; and Elton B. Fox, Northern California.

## Forecasts Steady Advance In Aircraft Improvements

by J. H. CARPENTER, Field Editor

WILLIAMSPORT Group, Dec. 1—Steady improvement, rather than phenomenal changes, probably will mark future trends in commercial aircraft, according to C. C. Furnas. The director of Cornell Aeronautical Laboratory, speaking before this Section meeting on "Future Trends in Aviation," forecast a continuing research and development program that will bring the benefits of the newer things in aviation to the public at a quite steady pace.

Focus of attention of most research work in commercial aircraft, he said, is on speed, safety, comfort and reliability. Aerodynamic constructional research will make significant contributions, but it is anticipated that the developments that will be most evident to the public will be in safety, comfort, and reliability.

One of the prime requisites of a satisfactory air transport, he said, is that it should be practically independent of weather. Adaptation of various radar devices to the development of

reliable blind landing systems, coupled with heat deicing for wings and propellers, should in the near future bring us to the point where commercial aircraft flights can be completed 99% of the time, as contrasted to the present average of 91%. This will make a tremendous difference in the confidence the traveling public will have in aviation, and increase the number of potential passengers.

In the field of comfort, Furnas anticipates distinct improvements in elimination of noise and vibration, in proper air conditions and in pressurization of cabins at ground level conditions throughout flight.

Safety, like morale, is made up of many small things—and it is always in the forefront of manufacturers' and operators' thinking.

Average airliner speed in the near future, he said, can be expected to be in the bracket of the transport planes now flying: from 225 to 300 mph. The bulk of air travel in the United States a year from now probably will be carried in moderate-size planes of about 40 to 60 passenger capacity. There will be a number of smaller feederline planes, and a few of 80 to 100 passenger capacity, but it is not expected that any of the super-sized planes will be used for some time. For transoceanic travel, most operators are thinking about 100-passenger-capacity planes.

Planes now going into use are those that have been under development for the past five years. A four- or five-year lapse is expected before any radically new transport designs will be flying the air lines. After that lapse of time, it may be anticipated that a good many very large planes over 100 passenger capacity may be in use, and the de luxe service will be available at cruising speeds of 500 to 600 mph—if (and it is a rather large if) the public is willing to pay for really high speed.

Military aviation development—well on its way, Furnas said, to entering the Buck Rogers era—focuses attention on two research items of paramount importance. The first is that of high speed. All trends point toward speeds greater than the speed of sound. This necessarily involves a great deal of aerodynamics as well as structural research into a region that heretofore has only been discussed and experimented with lightly.

The second phase, and an even more complicated one, is that of the automatic control and detection device of these guided missiles. This work consists essentially of substituting electronic and mechanical devices for the eyes, brains and muscles of a human pilot. There are a number of approaches to this problem that are still highly restricted. But it can be said that the research work is going forward rapidly—and it is highly fertile

hunting ground for the physicist and specialized mechanical engineer.

Devices for propulsion at extremely high speeds also are the subject of a good deal of high-powered research. The role of the turbojet engine is now well known, and it has carried the speed of military aircraft up to 600 mph. Still other advances in propulsion are under way which can be expected to carry speeds well above that of sound, at least for the guided missiles, and perhaps even for the inhabited aircraft.

## Discuss Selection Of Light-Duty Trucks

by WILLIAM H. CROUSE, Assistant Field Editor  
METROPOLITAN Section, Nov. 19—With William E. Conway of Studebaker Corp. acting as master of ceremonies, a panel of experts answered pertinent questions on design and operation of small trucks, at a fast-moving, "Information Please" type session at the Hotel Pennsylvania. Panel members included William C. Black of Adam Black & Sons, Inc.; Theodore A. Drescher of Bordon's Farm Products; Harvey H. Earl of United Parcel Service; John W. Limpert of Standard Brands; Robert W. Thomas of Quality Bakers of America Co-Op, Inc., and James Murphy of International Harvester Co.

Problems discussed included gross vehicle weight versus engine horsepower, body and chassis materials and designs, engine capacity versus economy, roadability, service accessibility, driver considerations, brakes, and tires.

Emphasis was placed on the necessity of selecting equipment to do the specific job required. It was pointed

out that while short wheel base trucks of 102 to 110 in. are generally satisfactory for urban operations, experience indicates that wheel bases up to 135 in. are desirable for suburban or interurban operations.

The question of using a 6-cyl as opposed to a 4-cyl engine provoked especially lively discussion with considerable interested audience participation. While some advocates spoke warmly of the greater economies inherent in the 4-cyl engine, 6-cyl adherents pointed out its considerable advantages in stop-and-go, heavy-traffic conditions. In addition, it was suggested that more frequent overhauls and faster wear of clutch, transmission and other parts in 4-cyl equipment might tend to outweigh the economy factor. The point was made, too, that driver satisfaction and its effect on productivity must be considered.

The short life and additional maintenance involved in use of undersized trucks was discussed, and it was suggested that two major factors are responsible for continued sale and use of such equipment: first, overzealous and under-informed new salesmen tend to oversell their trucks; and second, price-conscious purchasing agents may not always grasp all the implications involved in the purchase of the lower cost truck.

The problem of combatting engine sludge caused by cold engines in city stop-and-go driving was canvassed. Operators can employ such improvisations as covering the radiator, or removing or reducing the size of the engine fan to retain engine heat. But it was suggested that this actually is a manufacturer's problem.

However, it was agreed that in today's big-demand market where the emphasis is on mass production, the difficulties of engineering and building for such special requirements are tremendous.

## Points Probable Trends In Fuels for the Future

by A. K. MILLER, Field Editor  
ST. LOUIS Section, Oct. 14—Problems involved in development of "Fuels of the Future" were discussed at this meeting by T. B. Rendel, assistant manager of Shell Oil Co.'s Aviation Department.

Rendel divided internal combustion engines into two classes—the continuous combustion type and the batch combustion type. The engine designer and fuel technologist have the same problems: to introduce fuel and air in the right proportion, and to provide for digesting this fuel and air to extract the greatest possible amount of heat energy in the smallest possible space and to quickly eliminate the waste products of combustion.

### CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by Section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to Dec. 12.

The gas turbine, Rendel predicted, will, within the next 10 years, replace to a large extent the slow-speed reciprocating engine. Fuel engineers have overcome problems of burning fuels at sustained high speeds.

In the aircraft field, the troubles of handling a fuel throughout a wide range of temperatures and under a wide variety of storage conditions considerably restrict the type of fuel that can be used.

A kerosene type of fuel has generally been used, but handling this fuel under the wide range of temperature conditions involves a considerable degree of fluidity at low temperatures. This means the kerosene must be very light, almost in the naphtha range.

Depending on the temperature, fuels may contain as much as 0.015% of water dissolved in the fuel. At low temperatures, ice crystals are precipitated and may plug the fuel filter well above the cloud point of the fuel.

Present fuel specifications, Rendel said, impose restrictions (perhaps too severe) on freezing point and viscosity. An important cooperative problem is to determine whether the test methods currently applied are significant in terms of actual operation and, if necessary, to develop adequate and significant methods and to settle limits. A research program has been organized by the Cooperative Fuel Research Committee to study these problems in the Thompson Products laboratories in Los Angeles.

For safety, Rendel said, a fuel of as high a boiling range as possible is needed, but viscosity must remain low at low temperatures. From individual tests, some qualitative data are available that show kerosene or low volatility naphtha to be less flammable than normal gasoline as measured by the rate of flame propagation. On the other hand, the explosive limit for kerosene may be in a much more dangerous range of temperature than gasoline.

"Combustion is influenced by mechanical or aerodynamic factors more than by the chemical composition of the fuel," he said.

Because of low storage capacity in high-speed aircraft, a fuel of high calorific value per unit of volume is desirable. Some data are available that indicate that fuel volatility, as indicated by the ASTM 10% recovered temperature, exerts some influence on carbon deposition and flame stability.

Variation in composition seems to have little effect when adjustment is made for the volatility effect. Combustion problems in the gas turbine tend to force the fuel requirements toward the gasoline range and away from the heavy kerosene types.

Reciprocating engines, designated as "batch" burners, have many years of

research behind them. Vapor pressure is most important in aircraft at high altitudes. At present, 7 lb Reid Vapor Pressure generally is satisfactory in fuel systems, but continuous research is necessary as new designs are produced. A fuel of low boiling range—not above 300 F for the 90% distilled—is required.

We should try, he said, to determine whether a significant difference can be shown between fuel with 10, 50, and 90% points of 158, 212, and 257 F, and a fuel with 10, 50 and 90% points of 167, 221, and 275 F. Final solution of this controversy is really required if the petroleum industry is to provide the maximum amount of aviation gasoline possible.

If we expect to continue our progress in anti-detonation, Rendel emphasized, we must have a significant and valid measurement of the anti-detonation qualities of the fuel. In tailoring a fuel to an engine for service operation, we must be sure its behavior is reasonably comparable to that required by the engine for the specific operation.

In conclusion, Rendel discussed development of the Coordinating Research Council, which has grown from 25 members in 1922 to a membership of 900 in 1947. He told of the part it will play in peace time and what may be expected of this organization in assistance to the fuel and engine manufacturer.

Captured German films showing the launching of German V-2 rockets were shown after Rendel's talk.

## Says Transport Gains Merit Better Highways

by A. A. ORNE, Assistant Field Editor  
CHICAGO Section, Dec. 9—Past, present, and probable future of commercial transportation were examined at this Truck, Bus and Railcar Activity meeting by Verne M. Drew.

Russell H. Johnson acted as technical chairman and master of ceremonies and introduced Fruehauf Trailer Co.'s director of research, who told of rapid progress made in the field of heavy transport vehicles—from 1,000,000 trucks and trailers on the highways in 1920 to 6,000,000 units by the beginning of 1948. On the basis of ton-miles, he said, 10% of all freight handled in this country will be carried on the highways in 1948—75 billion ton-miles. The motor industry provides a means of livelihood for one out of 11 people.

Future development in heavy highway transport vehicle depends not only on what vehicle engineers can accomplish but also on highway engineers. Even where highways are adequate to support heavier loads, Drew said, bridges on the highways are not. A

comparison of airplane with highway transportation shows that runways have been modified to match heavier, larger vehicles; road facilities have not.

Drew told of tests to be conducted soon by the National Research Council on the Pennsylvania Turnpike to study the effect on highways and bridges of vehicles with modified and new axle design and application. Results should determine whether the highway should limit the transport vehicle or the vehicle the highway.

Drew's talk was supplemented by a motion picture explaining the "gravity tandem suspension" as used by Fruehauf—a layman's view of the engineering features employed in the suspension unit.

Speakers table notables included: H. S. Manwaring, Section vice-chairman and past national vice-president for Diesel Engine Activity; W. H. Oldacre, Section past-chairman; George Stevens, Diamond T Motor Co.; L. H. Smith, General American Aerocoach Co.; Tom Prince, Fruehauf; Paul Fuller, General American Aerocoach Co.; Percy Bartlett, Bartlett Trailer Co.; and Schuyler A. Jeffries, past national vice-president for Truck & Bus Engineering.

## Calls Maintenance Key To Trimming Fleet Costs

by ARNOLD R. OKURO, Field Editor  
NEW ENGLAND Section, Nov. 4—Past-Chairman Howard Fritch introduced Speaker H. I. Sullivan to a large gathering of Section members and of Student Branch members, other interested students, and faculty members representing Franklin Technical Institute, Harvard University, Massachusetts Institute of Technology, Northeastern University, Tufts College and Wentworth Institute. The visitors were guests of the Section, introduced to the group by David A. Fisher, of Tufts' Mechanical Engineering Department, Section vice-chairman for Student Activity.

Dinner tickets provided by individual members will make it possible for the Student Committee to invite interested students to attend future meetings as dinner guests throughout the season.

Meeting was held in the Campus Room of the Graduate House at M.I.T., where Sullivan, a transportation consulting engineer, spoke on "The Importance of Maintenance in Making Bus & Truck Operation Pay."

Maintenance has become no small headache, Sullivan pointed out. Innovations such as torque converter torsilastic and duoflex springs; forced ventilation at fresh air circulation rates necessitating booster heaters with enough capacity to heat a six-room dwelling; air conditioning; refrigera-

tion; and greater use of diesel power have added new maintenance problems. At the same time, maintenance cost per mile for labor and material has doubled in the last five years, and price of repair parts is up about 50% over prewar cost. Continuing scarcities make costly reclamation necessary, and poor quality of materials shows up in broken crankshafts and pistons at low mileages.

The picture is not all dark, however, he said. Indications are that the cost peak has been reached; improved manufacturing practices limited cost of buses to a 40% rise; and there are many instances of better-than-prewar efficiency of factory and maintenance workers.

Maintenance is the one item, Robinson claimed, that stands out as a place for slashing costs. This can be done, he believes, and done very successfully, by focusing attention on:

1. Employee morale and ways of making workers more productive;
2. Close and detailed analyses of maintenance costs. For a fleet of 100 vehicles operating 4,000,000 miles a year, he said, \$3500 would cover an exhaustive maintenance-cost survey—and a saving of only 1/10¢ per mile in maintenance cost would write off the price.

## Stresses Importance Of Mating Truck to Job

by R. D. MANCINELLI, Assistant Field Editor

CHICAGO Section, Nov. 11—Efficient transportation by selecting and planning the motor truck for the work to be done was the keynote of the paper given at Chicago Section's third dinner meeting of the season.

Frank W. Haase, vice-chairman for Transportation & Maintenance, introduced guests at the speakers table and then presented Fred B. Lautzenhiser of International Harvester Co.

Lautzenhiser reported an increasing awareness among motor truck operators of the importance of functionality—brought on by considerations of income and operating cost, evidenced in precise examination of relevant factors.

But operators are too prone to overlook the simpler factors comprising efficient transport operations. For instance:

- Tractor-trailer combinations used where either 4- or 6-wheel units should be used;
- Straight trucks where tractor trailers should be used;
- Four-wheel trucks where 6-wheel units should be used;
- Under-powered or under-capacity equipment;
- Incorrect gear reductions;
- Insufficient top road speed;
- Incorrect load distribution—body

too long or too short on a straight truck—or fifth wheel improperly located on tractor and trailer axle.

Lautzenhiser guessed that almost every piece of transport equipment on the highways has something wrong with it from the standpoint of maximum efficiency. Reasons given for such incorrect usage were:

1. Insufficient preliminary study of the truck operation;
2. Inadequate and too-cheap equipment;
3. Change in operation requirements after equipment has gone into service;
4. Change in state law restrictions after equipment has gone into service;
5. Insufficient knowledge of transport equipment to permit intelligent preliminary study.

He defined efficient highway transport operation as transportation of "the maximum load units at the best possible speed, and in continuous operation, with the highest degree of safety, at the lowest cost per unit."

He defined each of these terms, and documented steps to be taken in making a survey that will achieve efficient transportation. He showed how to calculate load distribution, and listed benefits derived from the well-balanced motor truck.

If he were a purchaser of motor trucks, he claimed, he would expect the truck salesman to submit not only design specifications and prices, but other more functional material such as load distribution layout, performance ability tabulation, operation cost estimate and evidence of legality of size and weight of the proposed motor truck.

In conclusion, Lautzenhiser described the work of the SAE Committee on Classification and Evaluation of Transportation Engineering Formulas, commending Carl Parker of Diamond T Motor Co. for initiating the general subject. Only an organization like the SAE, he pointed out, could bring about the standardization of such formulas for properly selecting and planning the truck for the work it must do.

## Probes Intricacies Of Electric Systems

by ARNOLD R. OKURO, Field Editor

NEW ENGLAND Section, Dec. 2—High present-day electrical loads on passenger vehicles, heavy-duty buses and marine equipment call for periodic visual inspection, meter testing, reoperation of the cranking motor and servicing if unnecessary failures are to be reduced.

Maintenance procedures were described in detail at this meeting by D. J. McLeod, New England service manager for United Motors Service, who emphasized with the aid of schematic diagrams the demands placed

on cranking motors and charging circuits.

Present electrical loads, he said, require use of a two-brush generator plus the reverse current relay, a current regulator and a voltage regulator. Inasmuch as generator voltage depends on armature speed and the magnitude of magnetic flux set up between the pole shoes, a current regulator is necessary as an external control to limit the output of a two-brush generator at the maximum rated output. Voltage regulator and current regulator operate in-

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dependently as required by the load demand or battery condition. Passenger car generators complete the field circuit through an externally-mounted apparatus box; heavy-duty generators have internally-grounded fields.

McLeod concluded with a few tips for operating and maintaining electrical equipment:

1. Standard duty generators and regulators must be tested on a closed circuit with the regulator in the same position as used on a particular vehicle, and at operating temperature. Heavy-duty units may be tested on open circuit at operating temperature

with close attention to service specifications.

2. Higher outputs require more careful adjustments to exacting tolerances.

3. Contact alignment is important in any unit adjustment.

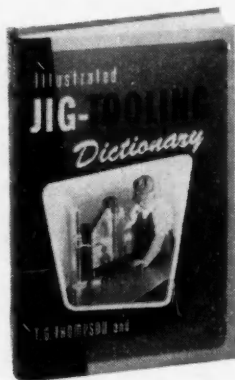
4. Contacts should never be closed on the reverse current relay; because of the low resistance, serious damage will result.

5. Heavy-duty regulators with four, five, and six units should be serviced with insulated tools, because an accidental short circuit might result in damage sufficient to ruin the unit.

6. Current regulators must be set with the voltage regulator contacts temporarily bridged by means of jumper connected across the VR contacts.

7. Temperature compensation through use of bimetal hinges attached to regulator armatures permits a higher operating voltage to overcome the increased internal resistance of the battery at low temperatures and the increased load imposed on the starting circuit.

From McLeod's complete description of the intricacies of electrical systems, it was evident that the qualified operator needs to possess, besides a working knowledge of electricity as applied to automotive circuits, a knowledge of Ohm's Law, the units of measurement, characteristics of series and paralleled circuits, fundamentals of regulation, electrochemistry of the storage battery, and the reverse current relay and its particular duty.



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## Examines Future Turbo Problems

by F. E. DEVORE, Field Editor

MID-CONTINENT Section, Dec. 5.—Over 150 members and guests, including groups from the Student Branches of the University of Oklahoma and Oklahoma A&M, attended this highly successful Section meeting. The program consisted of an afternoon tour through the Air Force Jet Engine Overhaul and the Motor Vehicle Repair Shop at Tinker Field, and an evening meeting with a War Department training film and a paper on jet engines.

The paper, "Notes on Turbojet and Turbopropjet Developments," was prepared by L. E. Shedenhelm, technical assistant to the director of the Aeronautical Center, CAA, and Hope Biggers, chief of the Technical Branch. Shedenhelm, who delivered the paper, is author of "The Pilot's Powerplant Manual," standard reference for pilots and mechanics.

Arrangements for the afternoon tour were capably handled by the Air Forces, and a discussion of cutaway engines was given by H. O. Schwartz of Tinker Field, who also contributed to the evening discussion.

Shedenhelm pointed out that aircraft speed five years ago was limited to about 450 mph because engines weren't sufficiently powerful, and engineers lacked knowledge of how to reduce drag. For example, it would take 5000 hp to reach 500 mph in a conventional aircraft, and about 50,000 hp to reach 664 mph at 40,000 ft. Turbojets provide tremendously increased power, but to use them to advantage, it is necessary to install them in the proper airplane configuration, and the problems of aircraft and engines are inseparable.

While estimated commercial demand for jet aircraft is 1-3%, Shedenhelm said, pace-setting competition could easily start a scramble for this type of equipment. Compressibility, which causes extreme buffeting, loss of control, and disintegration of the aircraft, is the present limiting factor on performance. For extreme speeds, shock-mounted cabins probably will be considered.

Two major problems turbojets and turbopropjets may assist in solving are "boundary layer control" and excessive frictional heating of the aircraft structure. Boundary layer control would make possible a 25% increase in speed with some designs, 100% increased lifting capacity, 32% reduction in fuel consumption, and numerous other gains.

It has been obtained in a high-speed, laminar-flow section through a series of slots located at 45% and 75% chord points. Many combinations are possible, and these slot openings may be about 1/32 in., using either pressure or suction obtainable in the engine.

While the radial engine will continue in use for many purposes, he reported, where the power requirement for a single unit exceeds 3000 hp, it becomes economically unsound. The Turbojet appears best adapted to interceptors, some types of bomber and other aircraft not requiring propellers. The radial engine is limited to cruising rather than sustained high-speed flight. Relative merits of centrifugal and axial flow compressors are controversial, and each has many inherent advantages.

Similarly, gas turbines have such advantages over radials as low development time, simplicity of production, greater power, advantageous shape, lack of vibration, light weight. Present disadvantages include low compression ratios with poor fuel economy, unavailability of turbine blade material capable of operating above 1500 F, tendency to "blow out" under some conditions, gyroscopic problems caused by rotation of the turbine-compressor shaft, and limited time between overhauls (from 60 to 150 hr).

The turbojet is basically a high-output engine, and must be operated above 90% of maximum power to obtain efficiency. Since its performance varies

with its velocity, some form of thrust augmentation is desirable for take-off and landing approach emergency acceleration (water-methanol injection, tail-pipe after-burning, adjustable tail-pipe nozzle, or JATO, for instance.)

Turbopropjets belong in the 3000 to 10,000 hp range, where the propeller will give reasonably good take-off and climb performance on commercial aircraft or long-range bombers. About 80% of the power is "shaft horsepower"; 20% is "jet thrust."

Fuel availability was cited as a major problem, since kerosene represents about 5% of fuel production. Usual "flash" type of aircraft fire is unlikely, but fuel tank explosion hazard is greater than with gasoline, since the air-fuel ratios in the tank are more likely to be lean enough to burn. A number of methods of purging the tank and reducing this hazard are possible.

Lubrication problems involve a need for mechanical and metallurgical developments of bearings and lubricants, capable of operating under elevated temperatures and rapid temperature change. Inertia separators appear promising in avoiding compressor icing trouble and removing sticks, stones, and so forth from the intake air.

Gradual improvements are bringing overhaul tune up, Shedenhelm said, and low time is not as serious as it sounds, since less equipment, time, material and labor are required than for conventional engines.

Discussion after the paper, handled by Biggers, brought out that the sonic barrier has never been passed by man, and that when it is, a craft with a skin approximately  $\frac{3}{4}$  to 1 in. thick will be required. Turbine blades have been cooled by hollowing and letting them pump cooling air centrifugally. Since the heat must flow outward away from the bearing, sodium cooling and similar methods would not be applicable.

Ramjets are limited to use in guided missiles, and are now capable of speeds up to 1500 mph. One of the main problems in developing a man-carrying supersonic craft is that it must not only accelerate through the sonic barrier but must also decelerate through it without disintegrating.

## Evaluates Factors in Diesel Fuel Combustion

by A. M. MILEY, Field Editor

PHILADELPHIA Section, Oct. 8—Prof. Paul H. Schweitzer of The Pennsylvania State College served as technical chairman at this Section meeting, when Dr. M. A. Elliott, of the Research and Development Division of the U. S. Bureau of Mines, spoke on "Combustion of Diesel Fuel Oils."

The combustion process in a diesel

engine, Elliott said, is a combination of physical and chemical processes. Transferring fuel and air into the combustion chamber, mixing these ingredients, and providing environmental conditions favorable to chemical reaction are the physical processes. Chemical process involves self-ignition or auto-ignition of the fuel and extensive chemical reactions which liberate the energy in fuel.

Fuel from the jet, moving at high velocity, disintegrates or atomizes and mixes with the air depending on air density and surface tension of the fuel. Greater disintegration of the fuel droplets provides more complete vaporization, which is a function of general and localized turbulence in the combustion chamber. The mixture of fuel and air prior to ignition is of a heterogeneous nature, with atomization, vaporization and mixing occurring simultaneously.

At present, Elliott reported, the law of diminishing returns has become apparent, so that serious attention is being devoted to investigation of the chemical aspects of combustion in the diesel engine.

The energy of reaction—the first chemical change—is due to a collision and rearrangement of the molecules having high velocities in the combustion chamber—of hydrocarbons, oxygen, and nitrogen. Thus collisions of additional molecules occur, accelerated by high temperature due to compression of the gases in the combustion chamber.

The auto-ignition of the hydrocarbons is propagated by a chain reaction phenomenon. The addition of ignition accelerators to the fuel will increase the rate of chemical reaction. Ignition delay can be further reduced by an increase of temperature and pressure.

When a small local region in the combustion chamber has ignited, with the proper air-fuel mixture, rapid combustion or inflammation follows. Combustion chamber design that provides good turbulence increases the rate of reaction during inflammation. The mixture in the chamber at this instance is exceedingly heterogeneous, with both oxidation and thermal decomposition reactions transpiring. There are definite indications that the velocity of oxidation depends on the fuel-air ratio and the overall average oxygen concentration. It is believed that thermal decomposition occurs at high rates at temperatures encountered during inflammation.

A knowledge of the products of incomplete combustion is important, Elliott emphasized, because they are a direct measure of combustion efficiency. Principal products of incomplete combustion are carbon monoxide, aldehydes, unburned or partially burned fuel, carbon polymerization products, and oxides of sulfur and nitrogen.

## Silicone News



### Longer Life for Generators

Before Silicone insulation was introduced by Dow Corning, electrical engineers had only one alternative when electric machines failed repeatedly because of overloads. They had to make room for a larger motor or generator regardless of how much it might cost. Silicone insulation offers a new alternative which is equally effective and much cheaper.

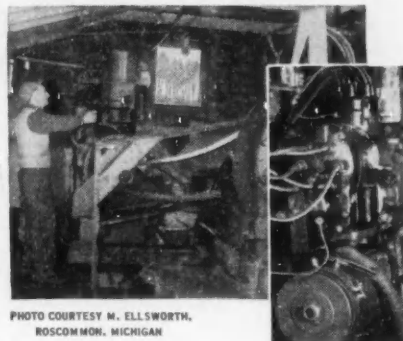


PHOTO COURTESY M. ELLSWORTH, ROSCOMMON, MICHIGAN

The auxiliary and starting loads of the 180 H.P. stationary gasoline engine which drives the hydraulic dredge shown above, require that the generator supply 25 amps at 12 volts to keep the battery charged. The generator had a rating of 17 amps at 12 volts. Such heavy overloading caused Class "A" insulated armatures to fail after two to five days of service. The dredge owner decided to try a Silicone rewind job. Rewound with Silicone insulation by the Chippewa Electric and Marine Company, of Midland, Michigan, the armature is still in service after five weeks of operation. That's seven times as long as the maximum service given by Class "A" insulated armatures—and it cost only three dollars more than a Class "A" job.

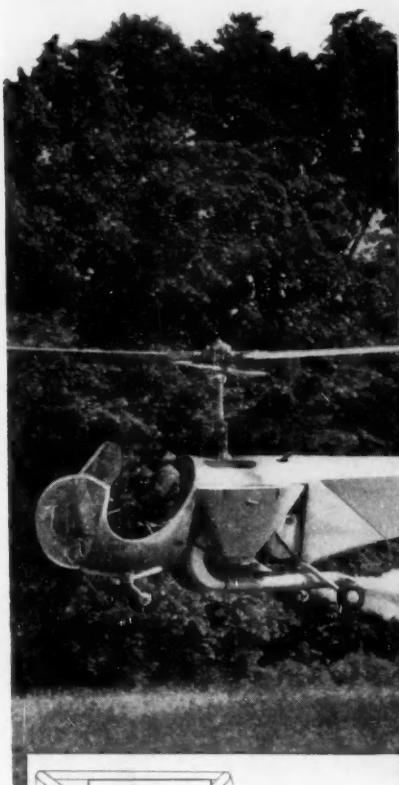
Silicone insulation will give the same kind of service in truck, bus, taxicab and aircraft generators. Chippewa has proved this, and now guarantees six months service for Silicone insulated armatures compared to the sixty day guarantee for ordinary armatures. Prospects are that Silicone insulated armatures can be made to last as long as the commutators.

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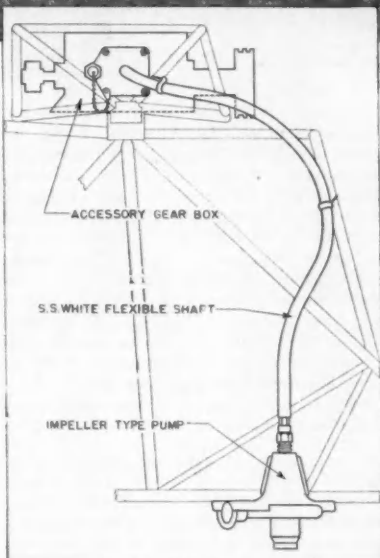
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## METAL MUSCLES\* for Bell's crop-dusting helicopter



Illustrations courtesy of Bell Aircraft Corporation, Buffalo, N. Y.

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The cetane rating of fuel oil, he said, is regarded as the ignition delay—consisting chiefly of the chemical delay in auto-ignition of the fuel. It would seem, he added, that an additional rating is necessary to directly measure performance of fuels during inflammation and evaluate the products of incomplete combustion.

Elliott praised fuel and diesel engine manufacturers for their work on the physical aspects of combustion, which has resulted in efficient and reliable diesel engines.

## Section Members See Biggest Tractor Made

by J. W. VOLLENTINE, Field Editor

**CENTRAL ILLINOIS Section, Oct. 20—**The new Allis-Chalmers HD19 Diesel tractor was one of the enthusiastically-investigated pieces of equipment when this Section visited the company's Springfield Works.

E. F. Norelius, consulting engineer for Allis-Chalmers, gave a short illustrated talk on the early history of the crawler tractor before the trip through the plant. Slides showed its design stages, from the early 1900's when wheel type gasoline engine traction machines had as many as four rear wheels and two extension wheels, each 6 ft wide and 8 ft in diameter, for a total of 36 ft in wheel width. Crawler-type tracks appeared from about 1902 to 1904, and front wheels were discarded in favor of the full track type design. The diesel engine appeared in the late 1920's, and soon almost completely replaced the gasoline engine, particularly in larger machines.

Design of the crawler tractor was relatively stable so far as major changes were concerned until recent years, when such items as torque converters, power assisted controls, super-charged engines and more power for higher speed operation appeared.

The relatively new Springfield Plant was laid out and organized for high production. General Motors supplies engines as well as forgings and castings, so that neither engine production facilities, forging shops nor foundry activities are required. The assembly is done on four mechanized lines.

Final testing, painting and shipping facilities are located in the area immediately adjacent to the end of the assembly lines. A new gear machining division recently was completed with the most modern methods and facilities. Heat treat facilities were extensive so that parts could be adequately prepared for the long and rugged service they must endure.

The new HD19 tractor weighs about 40,000 lb, and is equipped with a 163-bhp, General Motors 2-cycle diesel engine, a torque converter and hydraulic

## Picture of Progress

steering clutch control. The maximum draw pull of 36,000 lb is developed on average footing in first and reverse gears. The two forward speed transmission produces speed ranges from 0 to 3 mph and from 0 to 7 mph. The tractor is the largest in current production.

### Urges Freer Discussion Of Earthmoving Problems

by R. L. SWITZER, Field Editor

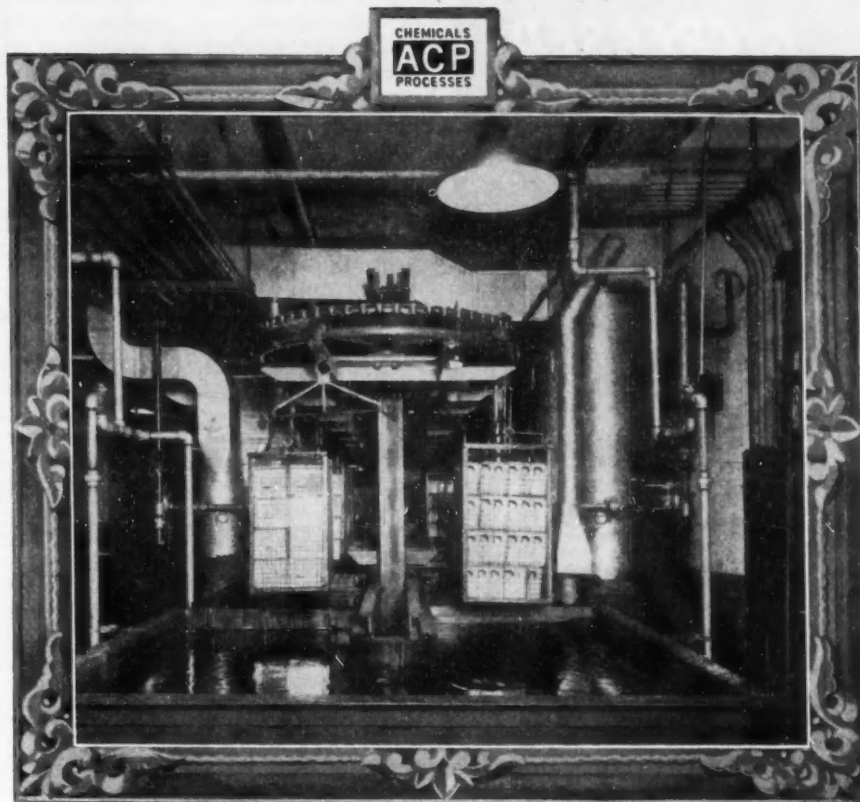
MILWAUKEE Section, Nov. 7—Although development of excavating and earthmoving machinery has advanced more rapidly than any other type of earthbound machinery during the past 25 years, engineers in this field were urged by Trevor Davidson to discuss their mutual problems more freely at SAE meetings.

The chief engineer of Bucyrus-Erie Co. said that since about 1920 the power used in this type of equipment has changed from steam engines and mules to internal combustion engines and electric motors. In larger units the diesel has completely replaced the gasoline engine, which was predominant in about 1935. As smaller diesel engines become more reliable, he expects them to replace some of the smaller gasoline engines in this field as well.

The basic job of digging and transporting material remains the same, Davidson said, pointing out that the proportion of digging to transporting determines the particular type of machine used. Where digging is the main object, there are a number of different types of shovels or dragline types, ranging in size from 9 to 150—and in special cases to 600—tons. These are capable of transporting material up to 400 ft without reloading, where cost makes it possible to use them.

Larger electric driven machines, used mainly in coal fields, have shovel capacities up to 40 cu yards—four times that of the largest diesel draglines. They are driven with 1000-hp a-c motors that will stand overloads of 100% for short time periods. The draglines have bucket capacities up to 30 cu yards, are powered with motors up to 1750 hp and have the same overload. It takes about 50 freight cars to ship them to their destination, and they must be assembled in the field.

When transportation is the major requirement of the machine, the scraper or bulldozer type is used, and the unit's size is limited to the size of the tractor available to power it. A single tractor limits capacity to about 15 cu yards. When two or more tractors are used for loading the scraper can be increased to 25 cu yards capacity. These larger units have a loaded weight of about 50 tons.



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This type tractor has a speed under 6 mph, so that the economical operating range is about 500 ft. Where longer hauls are required the units revert to the shovel and trucks do the hauling. This limitation brought about the evolution of the self-propelled scraper, mounted on rubber wheels and capable of 20 mph. Eight to 10 gear changes are used to attain this speed, selected by the operator according to roadbed conditions.

Operator's "feel," Davidson said, is a major item in the operation cycle. Hence the failure to date of torque converters, fluid couplings, and automatic transmissions. Theoretically ideal with the wide variations in load and speed encountered, they increase cost, create heat, and take away this important sense of feel.

Maintenance remains as one of the bigger neglected problems. Little preventive maintenance is done, Davidson said, and although handling of fuels and lubricants has improved, service facilities are poor. Usually a rough shed or a tree for a chain fall provides the place for a major repair. Dust conditions are bad, and good air cleaners and oil filters are a vital necessity.

## Records and Memories Theme of Race Meeting

by R. W. BIXLER, Field Editor

**SOUTHERN CALIFORNIA** Section, Oct. 23 - This Section's second meeting of the season drew a record 635 members and guests to the Coral Room of the Rodger Young Auditorium at Los Angeles.

Preceding the principal paper of this

Passenger Car meeting was a color film entitled "John Cobb's Record Run." The picture recorded the transport from England to the United States of the car Reid Railton designed, and showed its speed runs at Bonneville Salt Flats, Utah. (See SAE Journal, November, 1947, p. 61).

Ralph DePalma, the featured speaker, presented an interesting word picture of his racing days and his experiences with steel fabricated engines. DePalma said he brought the first steel fabricated engined car, a Mercedes, to the United States. The engine was sold to Packard Motors, and used as a basis for the Liberty engine. One of his outstanding experiences with a steel fabricated engine was when he finished a 500-mile race with a broken piston and bent connecting rod. The engine was repaired and went on to win three Elgin races and two 100-mile (dirt track) races.

Lloyd Taylor, designer of the pressed-steel Crosley engine, was present at the meeting to answer questions about this engine. He reported that the cylinders are of fabricated 4130 and 4140 steel, air quenched; aluminum alloy is used for the crank case; fabricated parts are held together by copper-brazing the joints; thinnest practical cylinder wall is 0.065 in.; the thin walls of the steel-fabricated cylinders are not greatly endangered by abrasion, for under similar conditions sand will wear away a steel cylinder wall 0.004 in., and a cast iron cylinder wall 0.032 in.; and thin walled materials allow more efficient cooling of valves and spark-plugs.

Taylor is now working on a steel fabricated engine of about 96 cu in. displacement, with which he expects to get over 100 hp at 6000 rpm.

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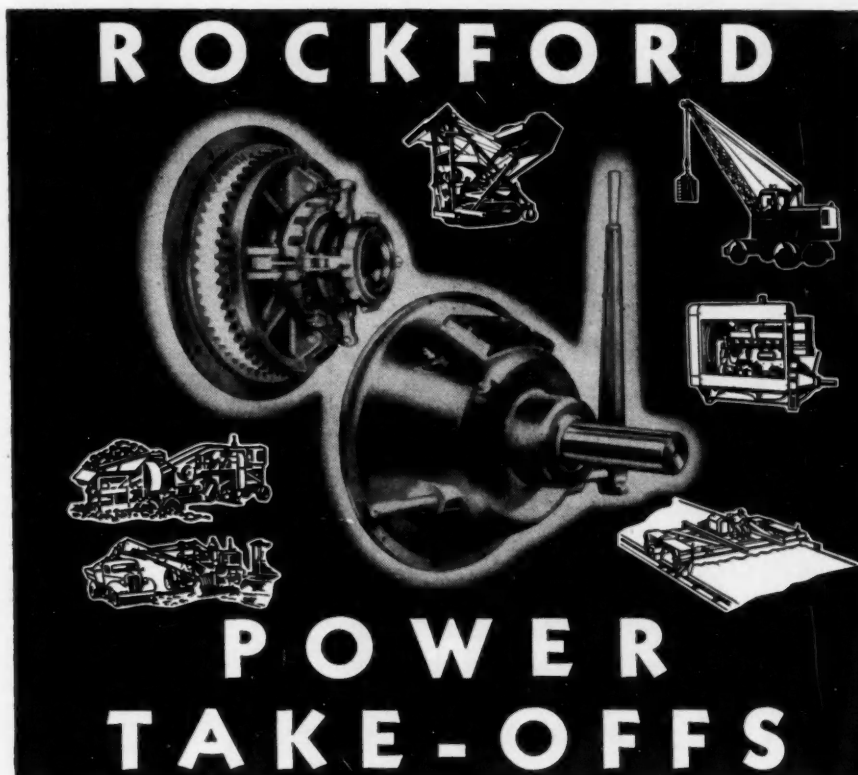
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## New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, and Dec. 10, 1947. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (Aff.) Affiliate; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: J. B. Myers (J).

British Columbia Group: Ray M. Higgins (A).

Buffalo Section: Stephen R. Kent (M).

Canadian Section: William G. Belfry (J), John Devlin (A), Paul Michael Samuel Stafford (J).

Central Illinois Section: Robert Richard Brian Backlund (J), Arthur H. Pickford (J).

Chicago Section: Joseph Pountifex Chamberlain (J), Virgil M. Exner (M), Glenn E. Foote (M), Louis Edward Hart (J), Richard C. Korff (J), Lloyd B. Little (A), Joseph Louis Nemeth (J), Thaddeus P. Perry (J), Oscar M. Pinsof (A), John W. Queen (A), Edward Wm. Ruehrwein, Jr. (J), George Alfred Underwood, Jr. (J).

Cleveland Section: George Atoulikian (J), Vaughn Y. Bell (A), Harvey F. Berghaus (A), Kenneth A. Brown (A), Robert J. Killian (M), Larry H. Kline (J).

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Detroit Section: Robert B. Alexander (J), W. J. Allard (A), J. Verne Coontz (J), William J. Crawford, III, (J), Robert G. Cummings (A), John B. Dickson (M), Robert G. Evans (M), Arthur P. Ferguson (A), Frederick Carl Foshag (J), Oliver S. French (M), David Roger Glass (J), Leon C. Greene (A), Donald Milton Hollabaugh (J), Robert Warren Hornbeck (J), David R. Hubbs (J), Weston Rowley Hutchins (A), Theodore R. Jamieson (J), Chester Karpiej (J), Thomas David Kosier (J), Eric William August Lange (J), John H. Lundy (M), Charles Grant McDougall (A), Robert B. Palmer (M), Robert William Platt (J), Kenneth Eugene Pyle (M), Lloyd Winston Schuhmann (J), Stewart W. Schulmeyer (J), John L. Searle (M), Walter H. Street (M), Reed Morgan Syler (J).

Hawaii Section: Earl Stanley Elmore (A), M. Russell Fozzy (A), Daniel W. MacMillan (A), Takeo Shibuya (A), E. Butler Smith (M).

Indiana Section: Robert F. Bostock (M), Edward M. Diss (J), Joseph Frank Slomski (J).

Metropolitan Section: William R. Cisney (A), George Demetrie Comnas (M), John E. Davis (M), Zola Fox (J), Robert Lee Francis (M), Ensign Har-



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Milwaukee Section: Frank C. Gokey (M).

New England Section: Theodore H. Eliades (J), Elton Hammond Tucker (A).

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St. Louis Section: Raymond K. Bucher (J), Kenneth E. Forster (A), Ernest S. Robson, Jr., (J).

San Diego Section: Donald E. Lovelace (J).

Southern California Section: Jack Thomas Belasco (A), Eugene E. Finch (A), Wendall M. B. Haas (J), A. H. Moore (M), George H. Powell (M), John H. Shandorf (A).

Southern New England Section: George F. Hausmann (M), Richard C. Hurd (J), Norman Russell Meise (J), Richard Cranleigh Mulready (J), Robert Kiehl Skrivseth (J), Robert Ernest Tschirch (J), Richard James Wills (J), John S. Witmer (A).

Spokane-Intermountain Section: M. Conner Ahrens (J).

Texas Section: John F. Dickmann (J), Harry D. Miller, Jr. (A), H. Phillip Scarborough, Jr. (A), George C. Younie (J).

Virginia Group: Burton C. Boesser (A), Grayson A. Brock (A).

Washington Section: Fred H. Esch (J), Comdr. Norval R. Richardson (SM).

Outside of Section Territory: Ervin V. Andrews, Jr. (A), Frank T. Carroll, Jr. (J), Sam T. Crawford, Jr. (M), Richard Gla Fuller (J), William P. Hilliker (M), William Lee Leonard, Jr. (J), Howard R. Munshaw (A), Roland W. Puder (J), Gordon Lloyd Scofield (J), Jack Harold Laubach (J).

Foreign: George M. C. C. Asselbergs (A), Holland; Alfred William Ballinger (FM), England; Walter James Belgrove (FM), England; Joseph Edward Bott (FM), England; Eric James Dunstan (FM), England; Eric Granville Vivian Gill (J), England; Harry James Harris (J), England; Jean Pierre Marchal (J), France; Edwin Haswell Moyes (FM), England; Douglas Price-Stephens (J), England; William Sparrow (FM), England; Leslie B. Sweetland (FM), England; William Henry Tait (FM), England; Ngo-Ming Tsu (J), China; Aatto Aleksu Wuorela (FM), Finland.

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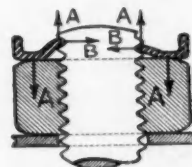
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Detroit Office: 3-213 General Motors Bldg.

## Applications Received

The applications for membership received between Nov. 10, and Dec. 10, 1947, are listed below.

Baltimore Section: H. Shelton Almony, Robert G. Blaylock, Horace E. Crawford, Capt. John H. Davis.

British Columbia Group: H. A. Burnett, Charles T. Stewart.

Buffalo Section: J. Robert Duppsadt, Frank W. Person, Jr., Charles D. Thomas.

Canadian Section: Robert Bruce Cornell.

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**Chicago Section:** O. K. Butzbach, H. B. Garvey, Richard A. Grest, Stanley McFarlane, John George Poulin, Robert O. Smith.

**Cincinnati Section:** William Gilbert Meyers, P. Lee Myers, Fred E. Nichols, William M. Seitz, Gene Steinkamp.

**Cleveland Section:** Howard J. Dieckow,

James Elmo Farmer, Frank W. Guertman, William G. Raney.

**Colorado Group:** Harold G. Davidson, Jr., Don Giacomozzi, E. C. Pleasants.

**Dayton Section:** Charles C. Speakes.

**Detroit Section:** William L. Bartholomew, Wayne A. Carlson, Charles Fales Cooper, Renato Riedel Osorio DePina, Robert Lee Dolan, Gustave Elko, John J. Ferszt, Edward V. Francoise, John F. Halbeisen, Robert S. Harmount, Walter B. Herndon, John Maguire, Edward H. Miller, Jr., Robert Campbell Pasco, Russell H. Peebles, Louis A. Selin, Steve Toth, Frank C. Weiler.

**Hawaii Section:** Eugene L. Craig, Robert S. Craig, Gilbert Hay, Jr., Morgan J. Haywood, Stanley O. Hornbuckle, Howard F. Ladd, Kenneth D. McNicoll, August H. Reimann.

**Kansas City Section:** Kenneth J. Holloway.

**Metropolitan Section:** Albert A. Araneo, Vernon M. Babcock, Thomas Edward Bailey, Edward M. Bell, James D. Bradley, Edmund H. Brockhurst, Fred Paul Burns, John Hays Caperton II, Thomas G. Chlestos, Howard Joseph Graninger, Caleb E. Hodges, Marvin J. Kohn, Daniel Bernard McElwain, Jr., George A. Viehmann, Eugene Frederick Zimmerman.

**Mid-Continent Section:** Alfred K. Young, William G. Allen.

**Milwaukee Section:** Dean Edward Rudig.

**New England Section:** David C. Bailey, Richard Donald Purcell.

**Northern California Section:** Rutter Arney, Ralph J. Doyle, Loren D. Poulsen.

**Northwest Section:** Charles E. Heniken.

**Oregon Section:** Stanley B. Loye.

**Philadelphia Section:** William F. Fisher, Ray E. Greeger, Theodore A. Kramer, Raymond Hunter Perry, Jr., John T. Richards, Theodore C. Scarlett, Alexander W. Stavarakis, Lawrence D. Vogt, Frank H. Whiting, Warren T. Zivie.

**Pittsburgh Section:** W. L. George, Herman Muster, Gustave A. Sill.

**St. Louis Section:** Julian G. Ryan, Herbert K. Sachs.

**Southern California Section:** Ernest C. McAfee, Jr., Thomas Clifford Jenkins, Francis J. Lucid, Jr., Rudi Miller, LeRoy Mylander, John W. Ree, Jr., C. W. Sawhill.

**Southern New England Section:** James Nassau, Harold Edward Robbins, Jr., George B. Wood.

**Syracuse Section:** Joseph V. Kielb.

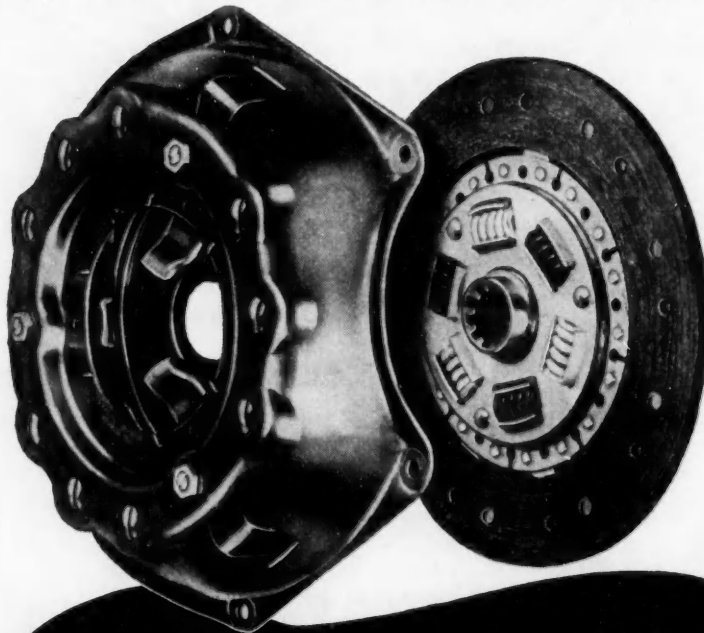
**Texas Section:** Earl W. Davis, Wilson M. Jones.

**Twin City Section:** C. E. Gobeil.

**Wichita Section:** Waldo Briggs Burnett.

**Outside of Section Territory:** Kenneth R. Ford, Carl David Johnson, Jr., Elwood F. Knapp, Alexander D. Lewis, William H. Love, Lebron B. McGonagill, Jr., Don R. Mitchell, Peter V. Toffoli, Jr., C. Hibbard Savery.

**Foreign:** Dr. Antonio H. deBacelar Carrelhas, Portugal; Addis Finney, Switzerland; Frederick Mervyn McCullagh, England; John R. Munck, Sweden; James Crockard Osborne, England; Frank Arthur Shorten, England; John Harold Weaving, England.



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